Vol. 13, No. 21.
January 19, 1889.

NEW YORK, U.S.A.

$3.00 Per Annum.
Single Copies, 10 Cts.

AMERICAN AND FOREIGN BOOKS
ON ELECTRICITY AND ITS APPLICATIONS.

ELECTRICITY, MAGNETISM, ETC., ETC.

Adams. Essay on Electricity $4 00
Angell. Elements of Magnetism and Electricity. Cloth, 238 pages, 151 illustrations 75
Anderson. Lightning Conductors. Cloth 6 50
Atkinson. Elements of Static Electricity 1 50
Ayrton. Lecture on Electric Railways 20
Ayrton. Practical Electricity. For students of electrical engineering. 516 pages 180 illustrations 2 50
Baile. Wonders of Electricity 1 50
Barlow. Magnetic Attractions 4 00
Barnard. First Steps in Electricity 75
Benjamin. Age of Electricity 2 00
Brennan. A Popular Exposition of Electricity. 191 pages 75
Blakesley. Alternating Currents of Electricity. Cloth 60
Bottone. The Dynamo. How Made and How Used. A book for amateurs. Cloth. 1 00
Cavendish. Electrical Researches. Cloth 5 00
Cook. Magnetism and Electricity. Cloth, 48 illustrations 40
Cumming. Electricity Treated Experimentally. Cloth, 100 diagrams 1 50
Davis. Manual of Magnetism, Galvanism, etc. 3 00
Deschanel. Electricity and Magnetism. Cloth 1 50
De Fonvielle. Thunder and Lightning. Cloth, 285 pages 1 00
De La Rue. Experimental Researches in the Electric Discharge with the Chloride of Silver Battery 3 60
Du Moncel. Electro-Magnets. Boards, 50c., English Edition 75
Dyer. Induction Coils; How Made and How Used. Boards 50
Electricity in the Service of Man 6 00
Everett. Units and Physical Constants 1 10
Fahie. Magneto and Dynamo Electric Machines 40
Faraday. Experimental Researches in Electricity. 3 vols., cloth 20 00
Fiske. Electricity in Theory and Practice. Cloth, 270 pages, 180 illustrations 2 50
Ferguson. Electricity. Cloth 1 50
Fleming's. Short Lectures to Electrical Artisans 1 50
Francis. Electrical Experiments 2 50
Gordon. School Electricity. Cloth, 262 pages, 139 illustrations 2 00
Gordon. A Physical Treatise on Electricity and Magnetism. 2 vols., cloth 10 00
Gladstone & Tribe. The Chemistry of the Secondary Batteries of Plante and Faure. 1 00
Gordon. Four Lectures on Static Electric Induction. Cloth 80
Guthrie. Magnetism and Electricity 1 25
Heap. Electrical Appliances of the Present Day Cloth 2 00
Hospitalier. Domestic Electricity. Cloth, 229 pages, 155 illustrations 3 00
Hospitalier. The Modern Applications of Electricity. Cloth 8 00
Harris. Rudimentary Electricity. Flexible, 69 illustrations 60
Harris. Rudimentary Magnetism. Cloth, 165 illustrations 1 40
Harris. Galvanism, Animal and Voltaic Electricity 60
Hering. Winding Magnets for Dynamos. 63 pages 1 25
Jeans. Lives of the Electricians 2 25
Jenkin. Electricity and Magnetism. Cloth, 177 illustrations 1 50
Kennedy. Electrical Distribution by Alternating Currents 80
Kohlrausch. Physical Measurements, with Appendices on Absolute Electrical Measurements 6 00
Lardner. Hand-Book of Electricity, Magnetism and Acoustics. 400 illustrations, cloth 2 00
Levander. Solutions of Questions in Magnetism and Electricity. Cloth 1 00
Lightning Flashes and Electric Dashes 1 00
Lloyd. Treatise on Magnetism 5 00
Lock. Workshop Receipts. Devoted mainly to Electrical and Metallurgical subjects. Cloth 2 00
Mahon. Principles of Electricity 5 00
Martin & Wetzler. Electric Motor and its Applications. 208 pages, 199 illustrations. 3 00
Mascart & Joubert. A Treatise on Electricity and Magnetism. Vol. 1, cloth, 654 pages, 127 illustrations 7 50
Maxwell. A Treatise on Electricity and Magnetism. 2 vols., 20 plates and 105 illustrations 8 00
Maxwell. An Elementary Treatise on Electricity. 6 plates, 54 illustrations 2 00
May. Bibliography of Electricity 2 00
McClure. Edison and his Inventions 75
Mendenhall. A Century of Electricity 1 25
Merwin. Patentability of Inventions 6 00
Miller. Magnetism and Electricity. 212 pages, illustrated 2 50
Munro. Electricity and its Uses. Cloth 1 40
Murdock. Notes on Electricity and Magnetism. Cloth, 38 illustrations 60
Munro & Jamieson. Electrician's Pocket-Book of Electrical Rules and Tables 2 50
Niaudet. Elementary Treatise on Electric Batteries. Cloth, 55 illustrations 2 50
Nipher. Theory of Magnetic Measurements 1 00
Noad. The Student's Text-Book of Electricity. Cloth, illustrated 4 00
Overend. Elementary Experiments in Magnetism and Electricity. Cloth 40
Parkinson. Ocean Telegraph to India 4 00
Parnell. Action of Lightning and Means of Defending Life and Property from its Effects 3 00
Plante. Storage of Electrical Energy. 268 pages, 89 illustrations 4 00
Pynchon. Introduction to Chemical Physics. 550 pages, 269 illustrations 3 00
Radau. Wonders of Acoustics; or, The Phenomena of Sound. Cloth, 288 pages, 116 illustrations 1 00
Rankine. Rules and Tables for Engineers 4 00
Reports of the Committee on Electrical Standards. Cloth 8 75
Rogers. Magnetism of Iron Vessles 50
Salomons. The Management of Accumulators 1 20
Spang. Treatise on Lightning Protection. Cloth, illustrated 75
Sprague. Electricity: Its Theory, Sources and Application. Cloth, 650 pages 6 00
Stewart & Gee. Electricity and Magnetism. 497 pages, 223 illustrations 2 25
Swinburne. Practical Electrical Units Popularly Explained. Cloth 60
Tarn. Magnetism and Electricity. A book for students 80
Techno-Chemical Receipt Book 2 00
Thompson. Elementary Lessons in Electricity and Magnetism. Cloth, 168 illustrations 1 25
Thompson. Recent Progress in Dynamo Electric Machinery 50
Thomson. Electro Statics and Magnetism 5 00
Treglohan. Frictional Electricity 50
Tyndall. Lessons in Electricity at the Royal Institute, 1875-6. Cloth 1 00
Watson and Burbury. The Mathematical Theory of Electricity and Magnetism. Cloth, 268 pages 2 75
Wonders of Acoustics; or, The Phenomena of Sound. Cloth, 288 pages $1 00
Woodbury's Protection and Construction of Mill Floors. Cloth 2 50
Welch. Table of Relative Weights of Copper Conductors 10
Woodward. Arithmetical Physics. Boards 80

TELEGRAPHY & TELEPHONY.

Abernethy. Commercial and Railway Telegraphy. Illustrated, cloth 2 00
Beechey. Electro-Telegraphy. Cloth, 36 illustrations 40
Clarke & Sabine. Electrical Tables and Formulæ. Cloth 5 00
Culley. Hand-Book of Practical Telegraphy. Cloth, 442 pages 6 00
Davis & Rae. Hand-Book of Electrical Diagrams and Connections 2 00
Douglas. A Manual of Telegraph Construction. 83 diagrams, cloth 6 00
Fahie. History of Telegraphy to 1837. Cloth, 529 pages 3 00
Field. History of Atlantic Telegraph 1 25
Globe Telegraph Code 2 00
Hoskiaer. Laying and Repairing Electric Telegraph Cables. Cloth 1 50
Hoskiaer. A Guide for the Electric Testing of Telegraph Cables. Cloth 1 50
Jones. Historical Sketch of the Electric Telegraph 2 00
Lardners. Electric Telegraph Popularized 1 50
Lockwood. Electricity, Magnetism and Electric Telegraphy. Cloth, 376 pages 2 50
Loring. A Hand-Book of the Electro-Magnetic Telegraph. Boards, 50c, cloth, 75c, morocco, 1.00 ..... 1 00
Maver & Davis. The Quadruplex. Cloth, 126 pages 1 50
Mullaly. Laying of the Cable 4 00
Pope. The Modern Practice of the Electric Telegraph. Cloth, 70 illustrations 1 50
Plum. The Military Telegraph During Our Civil War. Two vols., portraits and illustrations 5 00
Preece & Silveright. Telegraphy. Cloth 1 50
Prescott. Electricity and the Electric Telegraph. Cloth, 670 illustrations, 2 vols 5 00
Sabine. History and Progress of the Electric Telegraph. Cloth, 134 illustrations 1 25
Sauer. Telegraph in Europe 4 00
Schwendler. Instructions for Testing Telegraph Lines. 2 vols., cloth, illustrated 8 00
Smith. Manual of Telegraphy. 31 Illustrations, paper 30
Telegraphic Tests 5 60
Terry & Finn. Illustrations and Descriptions of Telegraphic Apparatus. Cloth, 92 pages, 30 plates 1 50
Williams. Manual of Telegraphy. Cloth, 327 pages, 90 illustrations 4 00
Dolbear. The Telephone. Cloth, illustrated 50
Du Moncel. The Telephone, the Microphone and the Phonograph. 70 illustrations, cloth 1 25
Lockwood. Practical Information for Telephonists. Cloth 1 00
Prescott. Bell's Electric Speaking Telephone. 526 pages, 330 illustrations 4 00
Thompson. Philip Reis, Inventor of the Telephone. Cloth, 3 plates and 48 engravings 3 00

ELECTRIC LIGHTING AND TRANSMISSION OF POWER.

Alglave & Boulard. The Electric Light. Its History, Production and Application. 458 pages 5 00
Cunynghame. A Treatise on the Law of Electric Lighting. Cloth 5 00
Day. Electric Light Arithmetic. Cloth 40
De Cew, Glacer. Magneto and Dynamo Electric Machines 3 00
Du Moncel. Electric Lighting. 66 illustrations, cloth 1 25
Dredge. Electric Illumination. 2 vols., cloth. Vol. 1 (scarce), $15 00. Vol 2 ..... 7 50
Electric Lighting Act, 1882, also the Rules of Board of Trade, October, 1882 ..... 2 00
Gordon. A Practical Treatise on Electric Lighting. Cloth 4 50
Grierson. Electric Lighting by Water Power 40
Hedge. Precautions to be Adopted on Introducing the Electric Light 1 00
Hedges. Central Station Lighting. Paper 20
Holmes. Practical Electric Lighting. Cloth 1 00
Higgs. Magneto and Dynamo Electric Machines. 301 pages 2 00
Kapp's. Electric Transmission of Energy 3 00
Maier. Arc and Glow Lamps 3 00
Prescott. Dynamo-Electricity. Cloth 5 00
Stephen. Wrinkles in Electric Lighting. Cloth, 45 pages, 23 illustrations 1 00
Sawyer. Electric Lighting by Incandescence. 96 illustrations, cloth 2 50
Schellen. Magneto-Electric and Dynamo Electric Machines. Cloth 5 00
Schilling. Present Condition of Electric Lighting 50
Schoolbred. Electric Lighting and its Practical Applications 2 00
Thompson. Dynamo-Electric Machines. Illustrated, boards 50
Thompson. Dynamo Electric Machinery. 57 illustrations, boards 50
Thompson. Dynamo-Electric Machinery. Cloth, 527 pages, 324 illustrations 5 00
Thurston. Stationary Steam Engines, especially as adapted to Electric Lighting Purposes 2 00
Urquhart. Electric Light: its Production and Use. Cloth, 94 illustrations 3 00
Du Moncel. Electricity as a Motive Power. Cloth 3 00
Kapp. Electric Transmission of Energy and its Transformation 3 00
Urquhart. Electro Motors. Illustrated 3 00
Walker. Practical Dynamo Building for Amateurs 80

TESTING AND MEASUREMENTS.

Haskins. The Galvanometer and its Uses. Morocco, 8 illustrations 1 50
Kempe. A Hand-Book of Electric Testing. Cloth, 494 pages 5 00
Lockwood. Electrical Measurements and the Galvanometer. Cloth 1 50
Smith's. Dynamometric Measurements 40

ELECTRO-METALLURGY, ELECTROTYPING, ETC., ETC.

Fontaine. Electrolysis. Cloth, 264 pages 3 50
Gore. The Art of Electro-Metallurgy. Cloth, illustrated 2 25
Napier. A Manual of Electro-Metallurgy. Cloth 3 00
Urquhart. Electrotyping. A Practical Manual 2 00
Urquhart. Electro-Plating. Cloth 2 00
Wahl. Galvanoplastic Manipulations. Cloth 7 50
Watt. Electro-Metallurgy, Practically Treated. Cloth 1 00
Watt. Electro-Deposition. Cloth, 568 pages, 144 illustrations 3 50
Wilson. Stereotyping and Electrotyping. Cloth, 195 pages 2 00

☞Copies of any of the above books will be promptly mailed, POSTAGE PREPAID, to any address in the world on receipt of price. Remit by Express or Post Office Money Order, Postal Note, Draft or Registered Letter. Address

ELECTRICAL REVIEW PUB. CO.

P. O. BOX, 3329. **13 PARK ROW, NEW YORK.**

ELECTRICAL REVIEW

ILLUSTRATED.

A WEEKLY JOURNAL OF

Electric Light, Power, Telephone, Telegraph and Scientific Progress.

VOL. 13, No. 21. WEEKLY. NEW YORK, SATURDAY, JANUARY 19, 1889. $3 per annum. Single Copies, 10 Cents.

Copyright, 1888, by ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York.

Entered at Post Office, New York, as Mail Matter of the Second Class.

The Chicago Electrical Exhibition.

Executive Chairman B. E. Sunny, of the National Electric Light Association, has secured the use of the mammoth Exposition Building of Chicago for the electrical exhibition to be made in that city by the members of the Association, during the Convention, February 19th, 20th and 21st, 1889. A convenient hotel for holding the Convention will be selected. A large number of exhibitors have already engaged space, and the display promises to be important, attractive and comprehensive.

Electric railway tracks will be constructed in one part of the great hall, and the electric railway companies will be strongly represented. Requests for space should be promptly sent in to Mr. Sunny, 148 Michigan avenue, Chicago.

Resistance of Alloys.

C. M. Weber, in Weidemann's *Annalen*, XXXIV, 1888, gives the results of some experiments on the resistance of alloys of tin and lead, and tin and bismuth, at high temperatures. Pure tin on melting, exhibits a sudden increase of resistance, and a similar phenomenon occurs with an alloy corresponding to the formula Pb_2Sn_7. In the case of other alloys, the increase of resistance may be classed under two heads; first, in the case of all alloys there is a rise at (the first melting point) about 180° C., and a further rapid increase of resistance until the fusion is complete; the former rise is the more marked the simpler the formula of the alloy. The alteration in resistance in all cases is somewhere about 50 per cent. For tin-bismuth alloys the case is different; these have all an approximately constant melting point about 140° C., but differ in their other properties. In the case of alloys containing only up to 12 per cent. of bismuth the melting point is not very noticeable, though apparently a little lower than pure tin; from 25 to 50 per cent. bismuth alloys the resistance suddenly decreases and then begins again to increase at 60 to 80 per cent. Bismuth shows a steady decrease of resistance during the whole period of melting; the smallest change noticed was in the case of a 54.5 per cent. bismuth alloy, but Herr Weber considers it probable that an alloy between 55 and 60 of bismuth, corresponding to the formula Bi_3Sn_4 would have a still greater alteration in resistance. Temperature co-efficients lie between 0.2 to 0.4 per cent., and 0.05 to 0.08 per cent. for the alloys in the solid and liquid state respectively. Herr Weber concludes from his experiments that the decrease in resistance of bismuth, when melted, is due to an essential property of the metal, and not to an accident of structure.

The Guy Wire and the Tree.

A New Orleans writer tells a story of what he calls "an electrical freak of a most peculiar nature" on Cameron street, in that city, which destroyed a shade tree on the sidewalk.

A guy wire from a corner electric light had been fastened to the tree, and this guy somehow become crossed with a live wire of the Louisiana Electric Light Company. Every time it rained the electricity ran down the guy to the tree, thence to the heart of the tree, and to ground. At times a spark was visible where the wire touched the trunk, about seven feet from the earth.

This had been going on for some time, and the circumstances reported to the company, but no attention was paid to the case. Finally a few nights ago, the contact had become more perfect and the tree commenced to smoke, while the odor of burning wood pervaded the neighborhood. In the morning the portion of the tree above the guy wire toppled and fell, having become weakened so as to be readily pulled down by the strained guy wire.

An examination of the stump showed that the heart and wood immediately surrounding it was far more charred and burned than the outer layers and bark of the tree. The tree had been converted in a large tube by the burning out of the wetter portion of the body wood of the tree.

FIG. 1.—COMBINATION FIXTURE, COLONIAL DESIGN.—The Mitchell Vance Company.

The Cambridge Division of the West End Railway.

On November 20th the Thomson-Houston Electric Co. started to equip the Cambridge Division of the West End street railway, of Boston, running from Bowdoin square, Boston, via Cambridge street, West Boston Bridge, Main street, to Harvard square, Cambridge (three miles), and thence via North avenue to Arlington, a distance of four miles, about six miles of which is double track and paved.

As the season was so far advanced it was first thought advisable to equip the line as far as Harvard square, and accordingly the rail connections were made from Harvard square to Bowdoin square and back. This work was completed Dec. 3d. In view of the fact that the cars on this division of the West End Street Railway run on a headway of about one or two minutes, it will be seen that remarkably good time was made by the Thomson-Houston Co. in removing the paving and drilling and connecting the rails without interrupting the traffic. The work of connecting the rails on North avenue is now also about done. The poles used in equipping this line are made of lengths of strong iron pipe firmly shrunk together, and are very neat and unobtrusive. There are three styles of these poles, it being deemed advisable to use a stronger one on the curves than was used on the straight stretches; 300 have been used from Harvard to Bowdoin squares. They are set in crushed rock and cement. The work of setting poles from Harvard square to Arlington is progressing rapidly, and already about one-third of the distance has been covered.

The overhead trolley wires will be placed in position this week and the work of fastening them to the cross arms will be commenced. In order not to interfere with the operation of the car during this work a large platform staging will be used which will permit passage of the cars underneath it. In connection with the work of equipping the line, it may be said that the Thomson-Houston Company has had to cope with several difficulties which would not enter into the construction of other lines in this city, and in the overcoming of which no little engineering skill has had to be employed. One of these points has been the drawbridge over which the two railway tracks run. Owing to its peculiar construction and situation, it has been found necessary, in order to effectually connect the wires, to design a special switch, which will be put in position in a few days.

FIG. 2.—ELECTRIC FIXTURE.—The Mitchell Vance Company.

The Thomson-Houston Company expect to have cars running to accommodate the public by the 1st of February.

In regard to the power station it is proposed at present to utilize the station of the Cambridge Electric Light Company, and place therein five 80 horse-power generators, and complete switchboard for operating the same. The steam plant is already being placed in the station, and work on setting up the generators has been begun.

When the road is equipped with the present order which has been received from the West End Railway Company, 20 cars will be running from Bowdoin Square to Arlington, each of which cars will have sufficient power to run a tow-car. All cars will be lighted with electric lights, and equipped with head lights.

Empire City Electric Company.

That the electrical industry is most rapidly developing, all our readers are well aware. One of the most conspicuous examples of this is to be found in the rapid advance of the Empire City Electric Company from a small supply house to a position in the front ranks of general electrical manufacturers and dealers. The company now occupies the entire building, No. 15 Dey street, New York, five floors and two basements, arranged so as to give every convenience for the transaction of business and the manufacture of electrical goods.

The energetic head of the company is Mr. O. E. Madden, so long executively identified with that magnificent property, the American Bell Telephone Co., and there has recently become associated with him as vice-president and director, Mr. E. T. Gilliland, whose ability in the electrical field is recognized wherever the subject is known, and whose work in the development of the telephone service of this country, both electrically and commercially, takes highest rank.

It is safe to predict that the growth and improvement of the business of the Empire City Electric Co. will become particularly noticeable with Messrs. Madden and Gilliland combining their abilities in the electrical and financial management.

Mr. E. W. Carritt is the well-known secretary and treasurer of the company, and, in addition to the gentlemen named, the directors are Mr. H. L. Storke, Mr. John A. Seeley, two prominent and well known telephone men, and Mr. H. G. Madden and Mr. F. C. Timpson.

The REVIEW has always had a warm feeling for these pioneer workers in the telephone field, and is glad to see that the conspicuous success they have won in the past is being duplicated in other circles which still are electrical.

Improvements in Electric Fixtures.

The Mitchell Vance Co., of 836 Broadway, this city, appreciating the growing demand in electric light circles for improved electroliers, combination fixtures and brackets, are continually getting out new designs of a quality of manufacture equal to the best efforts of this widely-known house. They are making a special feature of elec-

FIG. 3—COMBINATION TWO LIGHT BRACKET.

See next page.

tric light work, and we are pleased to present a few illustrations of some of their later and most attractive designs. The REVIEW is always glad of the opportunity of bringing to the notice of its many thousands of readers any efforts that are being made to beautify and make interesting the many valuable and practical features developing along the line of progress in electrical science, and the new administration of the

Mitchell Vance Co, is to be credited with noticeable work in this direction. There are probably no more attractive and artistically suggestive exhibition rooms in this country than are to be seen in this establishment on Broadway, where a special electric lighting system is in constant operation for exhibiting fine effects.

The Electric Matrix.

THE NEW INVENTION OF PRINTING NEWSPAPERS.

The "Electric Matrix Machine," the name of which does not disclose its real character, but which is, in fact, an invention to do away with movable type, and half the cost, spread and labor of a composing room for newspapers and cheap books. There have been many type setting machines, some of which work well and save labor, but this invention goes farther and abolishes type, just as the ordinary typewriter abolishes steel pens. Not absolutely, of course, but in a great degree, as I shall explain. It is a typewriter applied to printing, but in a novel way, which involves stereotyping for all that it prints. The machine works upon dry cardboard, such as is now used wet for the matrix of a stereotype plate; it stamps upon this cardboard a perfect matrix for casting a plate, and no sooner is the sheet withdrawn from the machine than the type metal may be cast into it. Thus the operation of stereotyping is shortened one-half both in labor and time; but the remarkable saving is in type setting and "justifying," distributing type and correcting proof, and the other manifold operations of the composing room. Every type being in this machine fixed in its place, and every movement in spacing, adjusting, etc., being made by machinery, the chance of error from type ill distributed is removed, and everything is held firmly together, so that no "galley" can be upset, and no form can be "pied." The proof-reading is done before the typewriter begins, and though there is a small margin for error in his work, yet a good printer who sees his letters correctly, and "spaces" and "justifies" in his mind, will make few mistakes. These, I am told, can easily be corrected, either in the cardboard before the column is cast, or by sawing out the wrong word from the plate. At most, it is but throwing away a cheap sheet of cardboard and printing the matrix on a new one, which can be done almost as fast as a printer can correct a bad proof.

The first inventor of this beautiful little machine is Mr. Capehart of Minneapolis, who a year ago was a skilled workman in the printing office of the Minneapolis *Tribune* and *Journal*, the two papers which the Haskells, father and son, now control in that northwestern city. Eighteen months or two years ago he began to work on the invention, and soon joined to himself Mr. Goodson, an electrician of Minneapolis, who has supplied the simple and effective electric movements, which enabled the machine to work. It requires $\frac{1}{10}$ of one horse power for its operation, as I saw it this week, and has five separate applications of electricity to the movements of the machine—which was built by the Ameses at Chicopee, and occupies no more space than a common ironing table. Yet one of these machines can print as fast as four ordinary typesetters, and faster than three good printers. Mr. Capehart declares that in the *Tribune* office the average typesetting rate (as shown by the payments made to each printer) is less than five words a minute, while his machine in a good printer's hands can set 25 words a minute on his cardboard matrix. Allowing for natural over-statement here, the gain of time must be considerable; and so is the gain of space in the composing room, of cost in the type, rules, chases, etc., and of accuracy in printing. No more beautiful sample of typesetting was ever seen than those which this machine produces, the intervention of the falliable human hand and the unguided eye being reduced to a small minimum by the use of machinery with accurate self-acting gauges and registers. Thirty of these machines are now making for the "Electric Matrix Company," which has its general office at Minneapolis, and branch companies at Chicago, Cincinnati and Boston. By February 1, these machines are expected to be all ready, and then the work of printing a great newspaper on them can begin.

—— The large and extensive factory of Kerr, Murray & Co. is now occupied by the Fort Wayne Jenney Electric Light Co. temporarily. The factory is being run by a double force of men, night and day, and they are now shipping apparatus and filling orders rapidly.

Lighting the Hoosac Tunnel

A year ago last November, there began a most difficult electric light venture, when the Fitchburg Railroad Company contracted with the Westinghouse Electric Light Company, of Pittsburgh, to supply the Hoosac Tunnel with electric light. The difficulty of pursuing this work may be imagined when it is understood that a torch sheds but a meagre, uncertain light through the Egyptian darkness, thick with smoke that incessantly prevails in the tunnel, while the

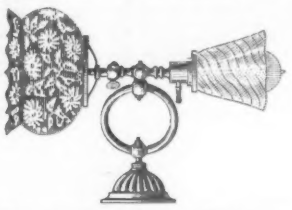


FIG. 4.—COMBINATION BRACKET.

workmen had to contend with the constantly dripping water from the roof and sides, the constant passing of trains, the sulphurous gases, and the prevailing damp that quickly rusted and corroded tools and metal parts of the works.

Through this tunnel, in the face of these obstacles, 40 miles of lead-covered cables were laid in wooden conduits, in trenches on each side of the tracks, an undertaking requiring extreme care and watchfulness, for a slight defect or an imperfect joint might have rendered necessary the taking up of miles of cable. Owing to the excessive moisture, the absolute perfect insulation of

FIG. 5.—ELECTRIC PENDANT IN FORM OF A BAT.

the wires for 8,000 feet of cable was rendered necessary. Power for the lights is furnished from a small building near the west portal of the tunnel, where two 125 horse-power boilers, a 125 horse-power engine, three No. 1 Westinghouse alternating current dynamos, each of 650 sixteen candle power light capacity, and two Westinghouse direct current machines for exciting the larger dynamos, constitute the apparatus. One dynamo will be reserved for use in case of emergency if either of the others breaks down.

FIG. 6.—COMBINATION PENDANT.

The lamps in the tunnel are arranged in sections of 20 fifty volt lamps each. In case of a break any section can be cut out without disturbing the rest of the system. Each lamp is provided with a choke-off coil, whereby, in case any lamp burns out, the rest of the lamps on the section will be kept burning.

A correspondent writes that the railroad company's objects were undoubtedly to afford the travelling public as great safety as possible, as well as to facilitate operations in the tunnel. With the tunnel all alight a greater amount of work can be accomplished by the workmen, and engineers can, on favorable days, in the absence of fog, see the track for nearly a mile ahead. A further design may have been to develop the popular interest that centers around the great bore, by making it more attractive to excursionists.

School of Electricity to be Established by Columbia College.

The Columbia College Trustees have decided to establish a post-graduate department in electrical engineering. For some time past the Faculty of the School of Mines has been discussing the matter.

The idea of the Trustees is to begin in a small and economical way, and if the study is well patronized to increase the facilities of the department. They therefore provided that there should be an instructor appointed

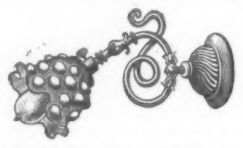


FIG. 7.—ELECTRIC BRACKET.

in electrical engineering and an assistant instructor, who should teach the theoretical branches of mathematical physics as applied to electricity and its relations to heat, magnetism and power. The course will be open to graduates of any scientific school in the country. The instruction will be illustrated with laboratory experiments.

The desire of the trustees is to secure the best man possible for the position. It is believed that New York City is the most desirable place for a school of instruction in electricity because of the many laboratories near at hand and the facilities for observation of practical work in electric lighting and in the use of electricity for motive purposes.

Philadelphia Lighting.

Philadelphia Councils' Joint Special Committee having charge of the proposition for the city to establish an electric light plant, met last week. A statement was made to the effect that the city was now paying $129,000 per year for 755 electric lights on the streets, when, for $300,000, a plant could

FIG. 8.—TWO LIGHT ELECTRIC LIGHT.

be erected that would furnish 3,000 lights, at an expense of $90,000 per year. In view of the award of contracts for next year, it was decided to first consult the directors of Public Works and Public Safety before taking any definite action.

* * A corporation styled "The Port Chester, White Plains and Tarrytown Railroad Company," has within the last few days obtained a franchise from the Trustees of White Plains, granting it the right to operate a line over the village streets. It is announced that this company intends to construct a railroad across Westchester County, connecting the New York, New Haven and Hartford Railroad at Port Chester with the Harlem Road at White Plains, and the New York City and Northern at Tarrytown. The project is the revival, in a new form, of a scheme which has been brought up at intervals for several years. The present company proposes to operate its railway by electricity, and its representatives express themselves as very sanguine about the enterprise.

Personal.

Mr. Theo. N. Vail has returned from a European trip in the best of health.

Mr. Irwin Z. Smith, of St. Louis, representing the Sunlight Carbon, is visiting in New York.

Mr. Tom Montgomery is expected back from Europe, and is reported to have made a fortune in Vienna this trip.

Mr. E. T. Gilliland, who spent the holidays with his father, at Adrian, Mich., has returned to New York much improved in health.

Mr. F. A. Cheney, of Elmira, N. Y., whose physical proportions are indicative of his electrical ability, was a New York visitor who was warmly welcomed by many friends last week.

Prof. L. J. Phelps, and Mr. S. K. Dingle, are now engaged in manufacturing an improved gas machine for lighting cottages, public buildings, factories, etc. Their office is at 115 Broadway; manufactory at Passaic, N. J.

L. B. Bidwell, Jr., of San Domingo, is visiting New York, and will remain in the United States and take in the Chicago Electric Light Convention. Mr. Bidwell is an experienced telegraph and telephone line constructor.

Mr. H. C. Adams has accepted the New York agency of the very enterprising and successful Ft. Wayne Jenny Electric Light Co., with headquarters at 115 Broadway. Mr. Adams is widely known in electrical circles and will be a strong man in the electric lighting field.

Mr. Stephen D. Field, who is engaged in farming as well as inventing at his country home at Stockbridge, Mass., spent a portion of his days and all his nights at the Electric Club last week. Mr. Field is enjoying the best of health and has gained 20 pounds in the past six months.

President Andrew Howard, of the Phœnix Glass Company, came over from Pittsburgh last week and conferred with the energetic, business-like manager, Mr. A. H. Patterson, of New York. Both gentlemen are well pleased with the way the electrical branch of their business starts off for 1889.

Col. Geo. L. Beetle, Prof. John P. Barrett, inventor Cobb, Mayor Roche, and electrician L. B. Firman represent as symmetrically intellectual and handsome a Chicago delegation as has visited the metropolis these many days. The Electric Club, of which several of them are members, was the scene of their most pleasant welcome.

Mr. Thos. L. Scovill, the New York manager of the widely-known wire manufacturing house of Holmes, Booth & Haydens, starts in the new year with a splendid business showing. Mr. Scovill, by wise and energetic methods, has greatly increased the volume of business, and will undoubtedly continue to reap abundantly from the growing electrical field during the year 1889.

Mr. Chas. Selden came over from Baltimore last week and received the condolences of his numerous friends over his recent unique and unlooked-for loss. His proprieship in a handsome Western home was rudely severed during a recent local cyclone, the house suddenly moving over into an adjacent county where pieces of it could be found in nearly every school district of one township. His insurance papers—and that is why he mourns—only covered loss by fire. Hereafter his Western investments will be insured against the elements, wind, water and fire.

Mr. John I. Beggs, the experienced and able vice-president and general manager of the Edison Electric Illuminating Company, of New York, will have, in the two electric light stations recently completed in this city, monuments to his skill and practical judgment of which he may well be proud. These two stations will be, when completed, probably the best equipped of any in the world, and are the result of years of study and experiment. Mr. Beggs will have his office hereafter at 432 Fifth avenue, where a large and conveniently arranged first-floor has been secured.

Atkinson Gas Engine and Pump.

The six horse-power Atkinson's "Cycle" gas engine, manufactured by the British Gas Engine Company (London), has a cylinder $9\frac{1}{2}$ inches in diameter. By means of the linkwork the piston has imparted to it four stokes for each revolution of the crankshalf. These strokes, all vary in length, being as follows: Suction stroke, $6\frac{5}{16}$ in.; compression stroke, 5 in.; working stroke, $11\frac{5}{16}$ in.; and exhaust stroke, $12\frac{5}{8}$ in.

The cycle commences, say, at the end of the exhaust stroke, the piston at this time being as close to the end of the cylinder as is compatible with safety, thus driving out practically all the residuum which is still further cleared out by the momentum of the exhaust gases in the exhaust pipe dragging a little air through the passages and small clearance space left. From an economical point of view it is now pretty well understood that the total elimination of the burnt gases is a desirable feature, in fact engines have recently been made which sacrifice an entire revolution for the purpose of obtaining this desirable object.

A short suction stroke is now made, followed by a slightly shorter compression stroke, the difference in the lengths of these strokes leaving a chamber into which, together with the clearance spaces, the charge is compressed. At this time ignition takes place and a long working stroke is made, followed by a slightly longer exhausting stroke when we arrive at the completion of the cycle, the whole being performed during one revolution of the crankshaft.

The exhaust valve is opened by a cam on the main shaft, the cam rod working a lever which opens the valve. The suction valve is operated in a similar manner. Both these valves open inwards, so that any pressure in the cylinder tends to keep them closed. They are also closed by one spring, which is arranged between them, operating through a yoke which presses against the ends of bridles on each of them. The gas governor valve is opened by the suction valve cam whenever the governor permits of its being so opened. The ignition is caused by the compression forcing a portion of the charge into a small tube which is closed at the outer end, and kept red hot by means of an external "Bunsen" burner. There is no valve in connection with this ignition arrangement, the timing of the ignition being caused by the chimney being raised or lowered. As the charge is always uniform throughout its volume, this gives a sufficiently regular ignition for practical purposes, and doing without a valve in this position gets rid of what has hitherto been the greatest source of trouble with gas engines. We are informed that several of these engines have worked for six months, ten hours every working day, without a valve being removed for cleaning, without the piston being taken out, and without a single bearing being adjusted. This seems coming within measurable distance of the simplicity and certainty of a steam engine.

The great economy of these engines is obtained mainly from two causes. In the first place, it will be seen that unlike any other gas engine, the expansion of the ignited charge does not end when it has reached the original volume of the charge, but is continued to any desired extent, generally about twice the original volume. This continued expansion adds about a third more work for the same consumption of gas; its value is very much increased from the second main source of economy, which is the rapidity with which the expansion takes place. Other gas engines expand to original volume during one-half of a revolution; this one expands to original volume during one-eighth of a revolution, so that work is done four times as fast. When it is understood that one of the greatest sources of loss is the passage of heat through the walls of the cylinder to the water jacket, it will be seen how necessary it is to do the work rapidly.

In all gas engines there is a heavy initial pressure, which in every other instance is transmitted to the crank-pin and main bearings. Here, however, this heavy pressure is transmitted directly to the long bearing of the vibrating link. This bearing is made the whole width of the engine, and is lined with white metal.—*London Engineering.*

The Electric Railway at Cleveland, O.

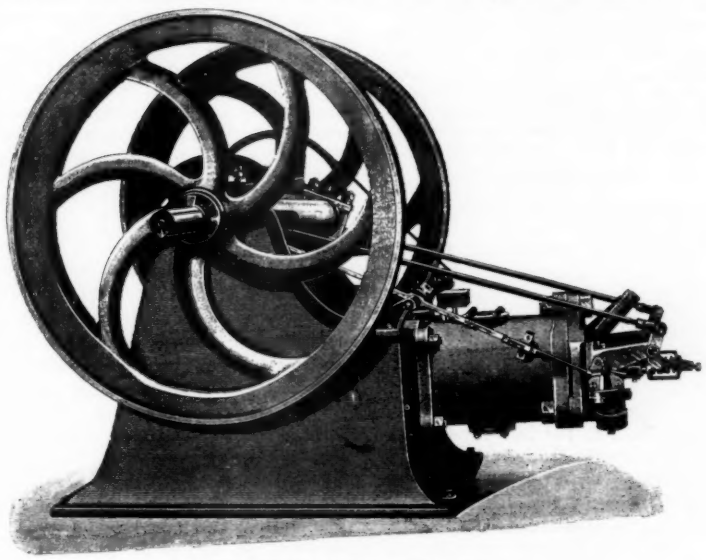
Recently another electric railway has been put into successful operation, and is now doing commercial work in transporting passengers without delay of any kind.

This is the East Cleveland Street Railway, of which Mr. A. Everett is president, and which has been installed during the past two months by the Sprague Co., and is operated on the overhead system, with small No. 6 silicon bronze wire as a working conductor.

The equipment of this road consists of 16 cars, equipped with electrical apparatus of the latest and most improved type, and all the latest improvements and devices used by the Sprague Co. upon their roads for increasing the durability and efficiency of their apparatus can be seen in operation here.

The power station from which the electric current is distributed to the line is situated on Cedar avenue, and is one of the most perfect electric plants of its kind in the country, and probably ranks next, if it does not equal, the Sprague electric power station at Boston in the completeness of every detail.

The size of the power station is 93x125 feet. The generating apparatus at present includes four powerful Edison dynamos wound for 500 volts, and 40,000 watts capacity each. The whole plant and power house is arranged for an easy increase in this capacity when there is any addition to the number of cars run, or increase in the length of line, and the motive power can be increased 1,500 h. p. without changing the line of machinery.



THE ATKINSON "CYCLE" GAS ENGINE.

The overhead system on this road is particularly light, and is remarkable for its neatness and unobtrusiveness. At night it is impossible to see any part of the overhead structure. It hardly seems possible that it can be a medium of transmission of nearly 250 horse-power of electric energy, distributed over so many miles of track, on which at any time the entire equipment of electric cars can be in operation. This working conductor is connected at intervals of 500 feet with the main conductor by short branch wires, and is of the same size as on all the Sprague roads, no matter whether one or 100 cars are to be operated, or whether one or 20 miles of track are to be covered. The main conductor is itself supplied at several wide distributed points by feeders which come from the main supply at the central station, and which maintain the potential of the line constant at all points of the road.

The return circuit is made through the rails, and thence by both metallic and ground circuit to the power station. Each section of rail is electrically connected with the next by copper plates, and at each five or six hundred feet along the line connected by ground wires with large earth plates, insuring practically no difference of potential between the rails upon any portion of the line.

The cars were operated entirely by the company's drivers, and none of the electrical experts present touched the switches.

The Sprague Company is to be congratulated upon repeating the recent success of the West End Electric Railway at Boston, at Cleveland, and upon having such a large number of electric railways in successful operation.

La Crosse, Wis.—The La Crosse Bridge and Transfer Company; capital, $100,000; incorporators, Joseph Tuteur, Adolf Candrian, C. F. Sharpf and others; object, to construct and maintain a bridge over the Mississippi river at La Crosse.

Newark, N. J.—The New Jersey and Pennsylvania Concentrating Works. The incorporators are: Henry M. Levor, Joseph Hutchinson and A. O. Tate, all of New York. The capital is $30,000, the place of business, South Orange, and the business is the refining and smelting of ores.

Joliet, Ill.—The Joliet Light, Power & Transit Co., at Joliet; capital stock, $300,000; to build and operate cable, horse, or dummy railways in the city of Joliet, and for the manufacture of gas and electric light and power; incorporators, Lewis E. Ingalls, John R. Staley, and Jason L. Wilson.

Newark, N. J.—The Edison General Electric Co. filed articles of incorporation in the County Clerk's office. The capital stock is fixed at $12,000,000, of which $1,000,000 has been paid up. The stock is divided into 12,000 shares at $100 each. The works are to be located at West Orange.

Minneapolis, Minn.—The Minnesota Phonograph Co., capital stock $312,000; the incorporators are T. B. Walker, C. H. Chadbourne and Seymour Van Cleve, of Minneapolis, and A. Y. Postlethwaite and F. A. Seymour, of St. Paul. The intention is to rent phonographs at $40 a year in the same manner as telephones are rented.

Worcester, Mass.—The Citizens Electric Co., of Worcester. Capital stock, $10,000. Will furnish light and power.

New Ulm, Minn.—The New Ulm Electric Lighting Co. Capital stock, $25,000. Incorporators, M. Mullen and others.

Monroe, La.—The Monroe Electric Light and Power Co.; capital stock $25,000; object, to furnish light and power for private use.

West Duluth, Minn.—The West Duluth Light and Power Co. Capital stock, $35,000. W. T. Tanner and others, incorporators.

Milwaukee, Wis.—The Western Electric Light Co.; capital $100,000; incorporators, Henry C. Payne, Frederick T. Day and William Plankinton.

Chicago, Ill.—Colby Gas Regulating Co., Chicago; capital, $150,000; to manufacture machinery; incorporators, E. J. Colby, F. F. Reed and T. B. Dyche.

Chicago, Ill.—The American Electric Railroad Co., of Chicago; capital stock $1,000,000; Hugh Henry, Stephen H. Emmens and H. Edgell, incorporators.

Milwaukee, Wis.— The European Fire Service Water Motor Co., of Milwaukee; capital, $200,000; incorporators, John C. Iverson, Geo. P. Mayer and Henry Schroeder.

San Francisco, Cal.—The Electric Laundry Co. Capital stock, $50,000, in 5,000 shares. O. R. Brant, Harry E. Brant, J. P. O'Brien, J. K. Conklin and W. Christon, directors.

Los Angeles, Cal.—The Rhodes & Kesse Electrical Co., Los Angeles. Capital stock, $10,000. S. J. Keese, T. H. Rhodes, W. J. Keese, G. W. Wells, J. F. Crosby, incorporators.

Middleborough, Mass. — Middleborough Electric Light & Power Co. has been incorporated, with a capital of $25,000. Wilbur A. Stiles is president, and George T. Ryder is treasurer.

Decatur, Ill.—Decatur Natural Gas and Oil Co., Decatur; capital, $25,000; to sink and operate oil and gas wells; incorporators, J. F. Payne, W. H. Starr, J. W. Alexander and others.

Savannah, Ga.—Savannah Electrical Co. Capital stock, $50,000. Herman Myers, John J. McDonough, William Garrard and others, incorporators. Objects to establish a burglar alarm and telegraph system.

Buffalo, N. Y.—Buffalo Steam Pump Co. The company purpose manufacturing and selling steam pumps. The capital stock is $150,000; trustees, Edward G. Felthousen, Daniel L. Volker, and William H. Sherman.

Chicago, Ill.—The Standard Gas Light and Fuel Company, of Cook county, Chicago; capital, $2,000,000; to manufacture and distribute gas and electricity; incorporators, H. S. Dickson, A. M. Maltby and John Duffy.

Portsmouth, Va —The Edison Light and Power Co. H. L. Maynard, president; John L. Watson, secretary and treasurer. The capital stock is $25,000. Plant will have a capacity of from 1,000 to 1,500 incandescent lights.

Denver, Col.—The Fort Collins Electric Company; capital stock of $50,000. William B. Miner is president and Frank J. Annis, secretary and treasurer. The system of lights will be extended to all the principal residence streets of the city.

Pittsburgh, Pa.—The Bessemer Gas Co., in Mifflin township, Allegheny county. The capital is $10,000, and the stockholders are Edward L. Clark, H. P. Smith and Robert B. Brown, of Pittsburgh, and William and V. E. Park, of Allegheny.

McKeesport, Pa.—The Fuel Gas Co., of McKeesport. The capital stock is $20,000, divided into 800 shares at $2,500 per share. The directors are H. W. Hitzrat, John B. Scott, J. E. Patterson, Isaac West, and Geo. Mars, Sr., each holding ten shares, and S. O. Lowry, C. W. Cronnonmeyer, C. E. Patterson and J. P. Learn, each holding five shares.

Victoria, B. C.—The National Electric Light and Motor Co., of Victoria, $100,000 capital. The objects the generation and sale of electricity for light and power, the construction and working of tramways, and the manufacture and sale of electrical goods of every description. The head office of the company will be at Victoria, where workshops will be erected.

New York.—Freeman Dynamo Electric Motor Company, 89 Liberty street. Capital stock, $250,000. President, N. Denison Morgan; electrician and general manager, Warren P. Freeman; secretary and treasurer, Robert W. Morgan. Directors, other than officers, J. W. Minill, Louis Bauer, Samuel C. Robinson, James H. Morgan. The company will manufacture dynamos and motors.

St. Louis, Mo.—The St. Louis Electric Light and Power Company, capital stock, $600,000, filed articles of associaton with the recorder of deeds yesterday. The stockholders are S. M. Dodd, J. C. Van Blarcom, J. W. Bell, Edward Whitaker, T. H. West, and J. C. Richardson, each of whom own 250 shares, and G. Pantaleoni, Pittsburgh, Pa., who represents 4,500 shares. The object of the company is to supply electric light and power to the public.

ELECTRICAL REVIEW

Published at 13 Park Row
P. O. BOX 3329.

GEO. WORTHINGTON, - - Editor.
CHARLES W. PRICE, - Associate Editor.
T. J. McTIGHE, Electrician and Manager Patent Bureau.

REGISTERED CABLE ADDRESS: "ELECTVIEW," NEW YORK.
TELEPHONE CALL, 546 JOHN.

Timothy W. Sprague, Room 58, No. 178 Devonshire Street, is our representative at Boston, Mass.
Mr. C. C. Haskins, City Hall, Chicago, Ill., represents the REVIEW in the West.

ADVERTISING.
Transient, 25 cents per line, nonpareil.

DEALERS SUPPLIED BY
The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N.Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, N. Y.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Toronto News Co., Clifton, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E.D., N. Y.

NEW YORK, JAN. 19, 1889.

CONTENTS.

	PAGE.
The Chicago Electrical Exhibition	1
Resistance of Alloys	1
The Guy Wire and the Tree	1
The Cambridge Division of the West End Railway	1
Empire City Electric Company	1
Improvements in Electric Fixtures	1
The Electric Matrix	2
Lighting the Hoosac Tunnell	2
School of Electricity to be Established by Columbia College	2
Philadelphia Lighting	2
Personals	2
Atkinson Gas Engine and Pump	3
The Electric Railway at Cleveland, Ohio	3
New Corporations	3
Mr. Acheson's Experiment	4
Shall Broadway have an Elevated Road?	4
News from all Points:	
Our Boston Letter	5
Our Chicago Letter	5
Our Washington Letter	5
Our Letter from the South	5
Letter from Southern California	5
Telephonic News	6
Liabilities of Telegraph Companies	6
The Newport Exchange Absorbed by the Providence Telephone Company	6
Major Martin and the Telephone	6
Mayor Hewitt's Opinion of the Electrical Subway Work of New York	6
Telegraphy in the Spirit Land	6
Healthiness of the Electric Light	6
The First Telephone	7
A Bill to Reduce Telephone Rental in New York State	7
An Aged and Historical Telegraph Pole	7
The Telephone	7
Submarine Telegraph Extensions	7
Telephones vs. Motors	7
Telegraphic	7
A Novelty in Telegraphic Systems	7
Electric Power	8
A New Electric Railway at Nashville	8
The Electric Resistance of Iron	8
The Boston Electric Club	8
Electric Lighting in San Diego, Cal	8
Book Review	8
Mining Machines Operated by Electricity	9
Photographing Bullets by the Electric Light	9
The Electric Light Bug	9
Electric Lighting in London	9
Electric Light News	9
Lighting Arresters and the Photographic Study of Self-Induction	9
The Lighting of Chicago by Electricity	13
Southern Electrical Notes	13
Conduits for Electric Light Lines	13
Electrically Welded Bale Ties	13
Los Angeles Lighted from Towers	13
Fire Alarm System for the Navy Yard	13
Electricity in Christmas effects	13
Manufacturing Notes	13
Electrical Patents	14

What does "candle power" mean when applied to arc lights? Would it not be well to definitely settle this little point?

When it comes to getting out original and information-giving calendars, we will back the electrical manufacturers against the field.

The effect of the copper syndicate on American production may be shown from the fact that during the year just closed the Lake Superior mines have produced 7,750,000 pounds, or 11½ per cent. more than in the previous year.

Professor Lodge's masterly investigation of the phenomena of atmospheric electricity might receive additional light and value, if accompanied by a collateral photographic study based on lines somewhat similar to those adopted by Mr. Acheson.

There is a strong inclination among many to call the recent storm that made such havoc in Brooklyn, electrical; but those who live near the gas works and had their houses shaken over their heads by the explosion of the "holder" insist that it was gaseous, not electrical.

That was an interesting description of the coming telegraphic system without wires, published last week in an evening journal, with Stanley in the heart of Africa in hourly communication with New York and London, etc. Perhaps it is a possibility, but we haven't heard of any one ready as yet to put any money into the scheme.

The Pacific cable project, a full account of which was published in the REVIEW in a recent issue, is reported to have failed for want of support on the part of the Canadian and Australian Governments. It is not so easy as it might seem to get $375,000 out of a government unless some substantial returns can be confidently predicted.

The Congressional Committee on lighting the Capitol at Washington will make no recommendation favoring any bidder, but will report the bids to the House with a joint resolution providing for the appointment of a commission to decide upon a plan and award the contract, and appropriating $125,000, a portion of which sum will be needed to prepare a place for the machinery.

As an illustration of how strong telegraphic and telephonic construction has to be in the northern sections of this country, it may be noted that the lines of the New England Telephone and Telegraph Company in the northern part of Massachusetts, which were broken down during the great storm of last week, were said to be carrying no less than four tons of ice to the pole when they gave way.

The first meeting in 1889 of the Electric Club, at its pleasant home, No. 17 East 22d street, New York, promises to be most largely attended. It occurs Thursday evening (January 17th) of this week, and will be addressed by Mr. E. N. Dickerson, which assures an evening of the highest instruction and of intellectual entertainment most agreeably and ably presented. No member of the Club should miss this meeting.

The experience at the Los Angeles, Cal., lighting station with crude oil instead of coal under the boilers, but corroborates what was long since proven. Oil gives an intenser and, above all, a more even heat than coal, not to speak of its convenience. Recently the Russian oil output has largely increased and American prices fallen, with the likelihood that they will be much lower yet. It will pay electric light and power men to look into this matter of crude oil for fuel.

Some inquiring individual has figured the millions of cubic yards of exhaust steam daily belched into our atmosphere, and to that cause attributed the unusual rainfalls and mild winter weather we have had lately. But the increase of steam power in the U. S. has not been so sudden the past few years as the enormous growth of the net work of wires and the tremendous amount of dynamic energy carried by them. Has this any connection with these atmospheric disturbances?

The ghost of "The Inevitable Anticipation" has again been seen. This time it was in Des Moines, Ia., where one by the name of M. F. Pease has suddenly remembered that way back in 1855 he invented the telephone, and filed a caveat in the Patent Office to that effect. When will this spook retire permanently to the inventor's limbo? Perhaps like Banquo's "It will not down!" And yet the Scottish phantom was conjured up by a guilty conscience. Can it be this which brings the ghost of dead invention to the fore sporadically?

It is with much pleasure that we notice that, on last Tuesday, the Board of Trustees of Columbia College unanimously resolved to establish a department of electrical engineering as an adjunct to the School of Mines. It will be for past-graduates of the School of Mines and of similar educational institutions. The advantages of a school of this kind in the City of New York will be incalculable, and, under the fostering care of Columbia, it will, without question, be creditable to the city and to the profession. We predict for it a rapid growth and an immediate usefulness.

If one critically observes the behavior of an arc lamp nowadays, especially those supplied by the lighting companies for indoor illumination, he will be compelled to admit a vast improvement over the arc lamp of a few years ago. It might be due to more refinement in manufacture, or better attention in trimming, or better regulation of the current either at the generator or engine; but whatever is the cause, the effect is notably superior to what it was but a few years ago. This is but the evolution of experience, and improvement must forever go on: invention cannot die.

The Consolidated and Equitable Gas Companies, of New York, feel grieved because the Health Commissioners have instructed their counsel to begin proceedings against them because their gas works have such an evil odor. The gas people claim that they cannot smell anything bad. Well, perhaps not; and then it must be remembered that the olfactory nerves are often sympathetically affected by that ganglion which controls the purse strings. Still, when we come to think of it, we seem to remember having noticed a faint, very faint, odor emanating from gas pipes and works in this city.

The lamp is to-day the most dangerous part of all electric light circuit, and more accidents occur at the lamp than at any other part of the line. Electrical people are, or have been, too apt to assume that at the lamp standing off the ground, the trimmer would not receive more than a gentle reminder in the way of one lamp potential. The trimmer too often gets "caught" by holding the frame of the lamp while he removes the carbon, while the lamp is merely short circuited, and not taken entirely out of the circuit by the switch. Whose lamp has a switch that removes the lamp from the line on both sides and does not leave it on a "third leg" when it is thrown? Don't all speak simultaneously, please.

The public is very apt to demand of its servants increased or better service at the same price which was paid for inferior work, forgetting that expensive construction and maintainance invariably calls for increased remuneration. Brooklyn is everywhere regarded as the pioneer city in underground telephone lines, and is at the present time in possession of a very perfect system of underground telephone conductors. As a result of this increased cost of plant, subscribers are now called upon to pay an annual rental of $120 where they used to pay but $90. The public will find that this same factor will hold good in all departments of electric service, and that if it clamors for underground electric light conductors it must be prepared to pay the bills, for it is evident that no one but the users of electric light can be expected to pay them. This, of course, is no argument against underground wires, but is a fact of which the general public at present takes but little cognizance.

MR. ACHESON'S EXPERIMENTS.

Mr. E. G. Acheson's earnest and painstaking work is doing much to explain the pranks of electricity, which have been puzzling to the very foremost of the world's physicists. We rejoice to see his independence of thought and the confidence with which this gentleman boldly marks out a line of experiment and then follows it conscientiously to its rational end. We hope to have more of such from Mr. Acheson.

But we would caution him about relying upon the supposed value of comparisons made with a series of different photographic plates. One variable in a test is all that science usually permits in order to reach a valid conclusion. But hardly any two sensitized plates are exactly alike; and the usual practice of developing a number of them in succession in one reducing bath which is continually changing necessarily introduces elements of uncertainty. We would suggest a repetition of this part of Mr. Acheson's experiments, to be made all on one plate, which could be shipped after each flash and then developed in a fresh bath, so that all the images would be made on a uniformly sensitive surface, and be subjected to exactly the same development and for exactly the same length of time.

SHALL BROADWAY HAVE AN ELECTRIC ELEVATED ROAD?

There probably is not a single resident of New York; no, nor even a person who occasionally visits the city, who would not regret to learn that on that boulevard, which might have appropriately been named the Aorta of America, and along whose miles of pavements drifts over a million of people daily, and in whose shops may be bought any article under the sun procurable for money, was to be erected the heavy, cumbersome, unsightly and smoke-begrimmed structure which impedes traffic, obstructs sunlight, and drips dirty water upon the unsuspecting pedestrian, on the side avenues of the great city. But it is said something must be done, for the present elevated roads, though they comprise four great parallel conduits through which a quarter of a million people are transported from their homes in the morning to their places of occupation, and home again at night, are crowded far beyond the point of comfort and almost beyond the point of safety. Nobody who gets on a train above Grand street, going up town, at the close of business hours, dreams of finding a seat. He meekly takes his place among the score of other unfortunates who are standing in the crowded aisle, and breathes the foul air which is rendered unnecessarily objectionable from the obtrusive presence of six badly trimmed kerosene lamps.

This great number of passengers, when simply stated in figures, makes but little impression on the mind; we need some familiar object to use as a foot rule, with which to measure them. Let us look for a moment at the coin which these passengers pass in through the ticket office windows each day. If all these nickel five cent pieces collected in one day were gotten together and placed upon the scales, they would weigh 5,357 pounds, or nearly two tons and three-quarters; if they were piled up, one upon the other, there would be a pile of coin 2,604 feet, or about half a mile high. If all these passengers were to join hands and stand in a row, they would reach from New York to Boston. From these comparative figures we get some idea of the enormous number of persons that patronize the elevated roads of New York. It is now proposed to construct a new road on Broadway for their better accommodation. What shall be its motive power?

The elevated road on Broadway, *must* be for rapid transit; nothing else will meet the requirements of the case. The steam elevated roads now in operation are too slow for the public demand. Now if there is one fact more sure than another in regard to the transmission of power, by a cable or wire rope, it is that its efficiency decreases very rapidly with its velocity. That is, the faster the cable goes, the longer will be the per cent. of power wasted in uselessly dragging it along. Even at the speed of surface street roads, the cable usually absorbs more than half, and often three-quarters of the total output of the entire steam plant.

It is obvious that the cable is made to move because that is the only way it can be made mechanically to do work. Why? Because mechanical work requires the motion of mechanical substances. Why not let the cable remain still (mechanically) and let energy in it do work (electrically) and manifest itself in power? Every electrical engineer knows that such a project is perfectly feasible. The difficulties which would be encountered would not be electrical, but would be purely mechanical; and the same mechanical ability and resolution which has built a Brooklyn Bridge or a Hoosac Tunnel would overcome them. And what an honor to the American metropolis and a credit to the whole nation, such an undertaking would be, if successfully completed—a road propelled and lit by electricity.

One more thing in this connection which merits attention is this: No great public work should be considered without relation to other public works. The folly of not doing so may be seen in the utter confusion and mutual interference of the underground wires, steam, gas, water, drain and other pipes now in the streets of New York. An electric elevated road the whole length of Broadway, being built of iron, and constructed with view of offering a means of carrying all the trunk line conductors of the city might solve the whole question of underground wires, which at the present time is far from being solved, and has proved to be utterly uncontrollable in the hands of the Board of Electrical Control. Such a road furnishing the city of New York with a means of transporting by electricity its million or more of inhabitants from their homes to their places of business, and at the same time offering the most convenient and safe conduit for the electrical conductors, which are absolutely necessary to the demands of modern civilization, would indeed be a triumph of engineering skill of which the profession might well be proud.

NEWS FROM ALL POINTS.

Electric Traction in Boston—Red Tape in Washington—California and the South Alive with Electrical Progress—Chicago News, etc.

OUR BOSTON LETTER.

The Electric Railway.—Regular running time was adopted Thursday on the Allston line of the West End road, and the electric cars began making regular trips every fifteen minutes from early morning until after ten at night. They continue to be crowded to their utmost capacity and are working with satisfaction both on the overhead Sprague system and the conduit line, Bentley-Knight.

A New Catalogue.—The Electric Gas Lighting Co. has just issued a model in the line of catalogues, "List F," which is a combined catalogue and price list of the complete line of gas lighting apparatus and electrical goods manufactured by the company. It is gotten out with the evidence of care and thought displayed which have marked its predecessors, and in arrangement and descriptive features it is even ahead of them. Among special features attractively shown by new cuts are the automatic sectional cut-out, new forms of annunciators, the Samson medical battery, the climax iron box bell and the Victor wooden box bell. The first portion of the book is given up to gas lighting apparatus, then follows the general electrical goods and on the last pages is given much useful information concerning batteries, arrangement of burners, general directions for putting in switches, coils and wires, illustrated with cuts, while a striking picture of Samson, whose battery strength is proverbial, appears on the back cover.

A New Agency.—Messrs. Dickerman, Adams & Company, 620 Atlantic avenue, have become New England agents for the Hartford Dynamic Company's popular switches. They are made double, three and four pole, and for from 5 to 40 amperes capacity. The firm are already meeting with success in this new field.

Personals.—Mr. H. D. Stanley, of the Bridgeport Brass Company, Mr. G. T. Manson, of the Okonite Company, and Mr. N. M. Beach, of Bridgeport, were Boston visitors on Thursday and Friday. Mr. S. A. Barton, general manager of the Thomson-Houston Company, has also been on from Chicago.

Dissolution of Partnership.—The well-known firm of Fuller & Holzer has become dissolved, and the business will be continued at 27 Arch street, by Messrs. Seth and Frank Fuller. This is in itself a guarantee of a satisfactory business. The firm will continue the electrical supply business and will as before do wiring for the Edison and other electric lighting systems.

New Electric Light Station.— The new station at Danvers, Mass., using the Brush system, was formally dedicated on Wednesday evening, a large party attending from this city. Among those present were Mr. O'Reilly, chairman of the street light committee of Pawtucket, President Brown of the Pawtucket council, Mayor Champlain and Councilmen Low and Fitz of Chelsea, Mr. Frank Ridlon of the Baxter Motor Company, Mr. C. S. Haley, special agent of the Brush company, and other prominent electrical people.

New Electric Company.—Messrs. Holzer and Cabott, well known in New England in connection with the firm of Fuller and Holzer, have become associated as partners in a new firm and taken quarters at 111 Arch street, where the opportunities for carrying a large stock of all kinds of electrical apparatus, will be fully improved. A manufacturing business will also be carried on under the supervision of Mr. Holzer and the new firm will act as one of the authorized contractors of the Edison Illuminating Company for incandescent light installation.

Important Removals.—Before the 1st of February the N. E. Wiring and Construction Company, and Messrs Paine & Francis, the Edison agents, will leave their respective offices and take up commodious quarters in the building corner of Pearl and Franklin streets, with entrance at 38 Pearl street.

The Bernstein Electric Co.—The Bernstein Electric Co. have removed their offices to the Hathaway Building, 620 Atlantic avenue, rooms F, G and H.

Sawyer-Man Co.—The Sawyer-Man Co. has made the following installations during the past week: Putnam & Co., Boston, 100 lights; J. B. Mason & Son (through G. H. Thurston & Co.), Providence, 82 lights. Mr. Wm. A. Carey, the superintendent of the New England office, has been in Pittsburgh for several days.

Dining at Young's.—The members of the Electric Club, to the number of 50 or 60, dined at Young's Hotel Friday evening, and enjoyed an excellent dinner and a very good time. President W. J. Denver was at the head of the table, and called for remarks on many gentlemen present, whose responses furnished much enjoyment. Several members of the New York Club were welcome guests.

Westinghouse Apparatus.—I wish to return thanks for several excellent photographs of the Westinghouse alternating current dynamo, motor and meter received through the courtesy of Mr. F. E. Alexander. At the office of the Westinghouse Co., at 620 Atlantic avenue, several of the meters are in place, and show themselves to be models of workmanship and design.

Electrical Contracting.—Mr. H. E. Swift has opened an office on School street, and will do a contracting business in all kinds of electro-mechanical work. Among other contracts now in hand Mr. Swift's wiring the Sear's building for the Gilman electric indicator system recently described in these columns.

Grimshaw Wire.—Mr. R. E. Gallagher, secretary of the New York Insulated Wire Company, has been in town several times of late, and as a result of his visits, the New England agency of the well-known Grimshaw wires and tapes has been placed with Messrs. Dickerman, Adams & Co., of 620 Atlantic avenue, who are handling several specialties in addition to their Eddy motor and general contracting business.

The Mather Motor.—Messrs. Claflin & Kimball, the New England agents of the Mather Company, have recently installed a 15 horse power motor of the Mather type, to be used in running an elevator on Purchase street.

Calendars.—Among the calendars recently received at this office, and for which our thanks are returned, are a handsome combination calendar and memorandum tablet from the Hartford Dynamic Co., the top of which presents a very pretty colored photogravure of the Connecticut capitol and memorial arch; a very pretty engraving from Messrs. Robbins & Appleton, the general agents of the Waltham Watch Co. and the Crescent Case Watch Co., and a neat colored lithograph from Messrs. Dickerman, Adams & Co., an unusually attractive marine view showing above the calendar paper.

T. W. S.

Boston, January 14, 1889.

OUR CHICAGO LETTER.

The Electric Club Unjustly Accused.—The *Times* of this city, in a recent issue, said that the Electric Club was a gambling den. The article created a sensation. The aforesaid paper wisely took it back the next day. It may have a libel suit to defend, as it is.

Insulation.—The question of insulation was discussed at the last club meeting by Messrs. Badt, Cutter, Thompson and others. Prof. Badt proposed a series of formulas. Another meeting will be held Monday evening to discuss this matter.

The Telephone Situation.—The telephone people in Chicago are in a very pleasant frame of mind. In conversation with one of the officers of the Chicago company he informed me that the applications for telephones on hand which have been in abeyance for so long (some 500), will be placed as fast as it is possible to install them, and the undergrounding of wires, in furtherance of the requirements of the authorities, has already been commenced.

Telephone Legislation in Ohio.—Ohio is getting ready for a tussle after the manner of Indiana, on the telephone rate business. In the House at Columbus the Clark bill was passed, which fixes the rental of telephones at $3.00 per month, and $2.50 where more than one is used. Should the bill pass the Senate the Central Union Company will simply withdraw from the field, and cease to do business in all the larger towns of the State.

Welcome Calendars.—The Western end of the REVIEW has received a very artistic and unique calendar from the American Electrical Works. It makes me sad when I gaze upon the picture, and am reminded of the flight of time, and the brevity of human life. The last time I saw Eugene, he was in the prime of life—but perhaps I am all wrong. This may be brer' Sawyer. Thanks, anyhow. Hazazer & Stanley, remembered this extremity of the REVIEW, also, with a vibrating bell calendar, invisibly to rattle off the days and months of the new year.

A Kind of Advertising Which Should Command Double Rates.—The Kalevala, the national epic of Finland, is the work from which it was said Longfellow had plagiarized Hiawatha. The metres are the same, and the office boy claims to have found the following prophetic acrostic in reading the book, as translated by Crawford. Ilmarinen was a mythological metal worker of the Fins:

Cunning workman Ilmarinen,
Ancient smith of Kalevala,
Northland's grandest wonder-forger
Dared the thunder-fire of Hisi.
Evil flaming fires of cloud-land,
Ever saved from harm, by wire screen.
When he claimed the bride of Northland;
In the serpent field of Lempo,
Racing with the wolf of Mana;
Eagle hearted Ilmarinen
In the river of Tuoni
Sought the monster pike of death land,
Grappled with the bear of Lempo,
Only for his magic copper,
Only for its wondrous wrapping,
Death had taken Ilmarinen.

C. C. H.

Chicago, Ill., January 12.

OUR WASHINGTON LETTER.

Bids for Lighting the Capitol by Electricity.—The bids for the Capitol lighting plant (advertised for in the ELECTRICAL REVIEW), opened yesterday by the House Committee on Public Buildings, were as follows:

BRUSH ELECTRIC COMPANY.

Electric Plant (not including engines)	$29,000
Fixtures (Archer & Pancoast's)	31,000
Porter & Allen Engines	36,000
Armington & Sims Engines	38,200
Watts-Campbell Engines	45,700

SAWYER-MAN ELECTRIC COMPANY.

Entire Plant, including fixtures	$73,484

UNITED STATES ELECTRIC LIGHTING COMPANY.

Four bids for Electric and Power Plant:	
A	$89,829
B	85,250
C	94,775
D	88,257
Four bids for fixtures (Horn, Brannan & Forsyths)	
A	$12,293
B	15,356
C	17,418
D	20,795

EDISON UNITED MANUFACTURING COMPANY.

Four bids for complete plant (including Bergman's fixtures at $13,233):	
1	$40,000
2	43,000
3	42,500
4	35,000

CONTINENTAL DYNAMO COMPANY.

Six Dynamos, 600 sixteen c. p. lamps each	$3,900

The Alternating System.—The Westinghouse Electric Company, not having an opportunity to make a regular bid for its alternating system, submitted a letter stating that the cost of such a system as they would recommend would approximate $80,000.

Beautiful Fixture Designs.— Proposals for fixtures were submitted by the Bergmann, Thackara and Schultz Companies, and by Horn, Brannan & Forsyth, with elaborate and beautiful designs, sufficient to turn the committee room into a picture gallery.

Government Bids not Always Profitable.—Representatives of all the bidders were present, full of enterprise and enthusiasm, but none of them expressed any high anticipations of making large profits out of government contracts. Perhaps some of them do not fully appreciate the really fine points in government bidding. On the same day another great department was expecting to open bids for electrical supplies.

The Beauties of Government Red Tape.—Ten days ago advertisements consisting of three large pages of fine print, bearing the marks of three or four clerks, and the signature of a high officer, had been mailed to six dealers. This document requested proposals, in duplicate, with legal guarantees, and provided every possible safeguard against loss to the government, with a provision for bonds from the fortunate contractor, and the supplies wanted were "six inches of hard rubber tubing, $\frac{3}{8}$ of an inch in diameter, in 2 inch lengths!"

Investigating the Underground Question.—Major Raymond, the district engineer commissioner, will leave for Boston early next week to examine underground wire systems, and will also visit New York and other Northern cities for the same purpose.

The Chesapeake & Potomac Telephone Co.—A meeting of the directors of the C. & P. Telephone Co. will be held to-morrow, at which the usual quarterly dividend of 1¼ per cent. will be declared. The reports will show a decided increase in receipts over last year. The vacancies in the board caused by the death of Mr. Frost, of New Haven, and Mr. Fisher, of this city, will not be filled until the annual meeting in February.

G. C. M.

Washington, January 11, 1889.

OUR LETTER FROM THE SOUTH.

Activity in the Electric Lighting Business.—At Birmingham, Ala., A. W. Fuller is organizing a company to erect an electric light plant.

The Sibley Manufacturing Company, of Augusta, Ga., have put incandescent electric lights in their cotton mill.

At Monroe, La., the Monroe Electric Light and Power Company has been chartered by F. G. Hudson, J. H. Andrews, M. J. Duty, and others. Capital stock is $10,000.

At Taylor, Texas, J. E. Land, representing the Western Electric Light Company, of Chicago, Ill., is negotiating to erect an electric light plant to cost $25,000.

The Piedmont Electric Illuminating Company contemplate increasing the capacity of their plant at Lynchburg, Va.

The plant for lighting the Ensley City (Ala.) furnace with electricity is nearly complete. Half the lights are already in use.

The Warner Iron Company, of Goodrich, Tenn., want to purchase machinery for an electric light plant as soon as possible.

The directors of the Edison Electric Light Company held their regular monthly meeting at Birmingham on the 1st of January. The reports of the various officers showed the company to be in good condition and its business on the increase, the capacity of the plant having been enlarged during the Fall by about 1,500 lamps. Among other things discussed were the purchase of additional machinery for the lights to be utilized at an early date. With the new Merchant's Electric Light Company, there will then be three companies in Birmingham furnishing this kind of lights.

Electric Road up Lookout Mountain.—The Gaynor Electric Company have secured contract to furnish the outfit for an electric railroad up Lookout Mountain. The company organized a year ago, and have now one of the largest manufacturing plants in the country. They employ more than 100 mechanics, and have doubled their capacity since establishment.

Telegraph Business Improving.—The Sampson River Telegraph Company have re-opened their line, and are now ready for business. This company was very much embarrassed by the yellow fever in Jacksonville, but it is now in a very prosperous condition.

E. A. O.

Charleston, S. C., January 10, 1889.

LETTER FROM SOUTHERN CALIFORNIA.

Westinghouse Alternating Plant.—Mr. G. D. Copeland, proprietor of the Electric Railway and Light Company of San Diego, has recently installed a 1,300 light incandescent plant of the Westinghouse alternating system, in order to utilize the steam plant of the power station for the electric road during the night. The plant consists of two Westinghouse alternating dynamos, with separate excitors, requiring about 50 horse power each when run with full load. Buildings in the business part of the city are already wired to the extent of 1,100 lights, and the system is giving satisfaction.

The Henry Electric Road.—Mr. Copeland's electric road is operated on the Henry system, and is the only one in existence of the kind. The power plant consists of four Henry dynamos, running the series, giving 260 volts. An overhead wire is used, with a trolley consisting of four grooved wheels gripping the wire. The circuit is completed through the rails. Mr. Copeland has a valuable franchise from the city, giving him the right to run an electric road through the principal streets of the city, in both directions. His present resources will not permit him to extend his roads as business warrants, and he therefore desires to get outside capital to complete the road. This is a good opening for some Eastern man, for Mr. Copeland is willing that the management of the road shall pass out of his hands.

The San Diego Telephone Exchange.—The following is from the San Diego *Union*: "The telephone exchange now numbers 284 subscribers, 37 of which are private houses. Six wires are in constant use between San Diego and National City, and connection has been made to Oceanside, Coronado, Campa, Tia Guano, Del Mar, and every important town near. The exchange was organized in 1881 by its present manager, Mr. G. W. Thompson, an old San Diegan, and one of the pioneer telegraph operators of the coast. * * * The telephone wire along the National City and Otay railroad is used exclusively as the railroad wire—which is believed to be the first instance where the telephone has superseded the telegraph for railroad purposes.

The Mather Plant in the Coronado.—The Mather plant at the Hotel Del Coronado, San Diego, is giving great satisfaction and entire dependence is placed on the system, no gas being used in the house. The average use is about 1,100 lights, but the building is wired for 2,800. A 60 light arc dynamo has been added to the plant, and furnishes light for the hotel and town of Coronado. The plant is in charge of Mr. F. V. Pinkham, a young electrician from the Mather Company.

Los Angeles City Lighting.—At a recent meeting of the Los Angeles city counsel the committee on gas reported in favor of making a renewed contract with the electric company. It is also proposed to try the experiment of changing the high masts to low ones in certain parts of the city, to see if a better distribution of light cannot be thus secured. The electric lighting company will therefore put 60 foot masts at the intersection of several of the business streets, and if the change proves satisfactory they will remain, otherwise will be removed at the expense of the city, which will then bear the whole cost of the experiment. The recommendation was adopted and a contract for two years with the electric company authorized.

Increasing Electric Light Facilities.—It is proposed by the Pasadena Electric Light and Power Company to issue bonds to the amount of $20,000 for the purpose of enlarging their plant. The bonds will be secured by a first mortgage on the real estate and plant of the company, and will bear interest at six per cent. A meeting of the stockholders has been called for February 21st, 1889, to consider the matter. Mr. Galbraith is president of the company, and L. C. Torrance, secretary. EDWARD G. THOMAS

San Diego, January 2, 1889.

Telephonic News

*** The American Electrical Works, with their usual enterprise, have published one of the handsomest calendars of the season. Mr. Phillips always has something new and unique of this sort, but has excelled himself this year.

*** The telephone patrons of Chicago, who are enjoying the great kicking act, have about concluded, since the St. Louis decision was announced, that the best thing for them to do was to appeal to the State Legislature.

*** Now, that the New York Legislature is in session, the usual bill to regulate telephone rates may be expected. It is already reported that the "Telephone Committee of the Board of Trade and Transportation" (whatever that is) has drafted a bill.

*** The New York and New Jersey Telephone Company has raised its rates to new subscribers from $90 to $120 a year. If a new subscriber contracts to keep the telephone for five years he gets it at the old rates. For old subscribers the rates are unchanged. The increased rates are due to the extra cost of making connections in putting wires underground.

*** Since the electric cars were started in Akron, Ohio, induction has interfered greatly with the telephone service. Last week the Central Union Telephone Company brought suit against the Electric Street Railway Company for an order to compel the latter to remedy the trouble and for a restraining order to prevent the extension of the system until such provision is made.

*** January 1st, the Cushman Telephone Company, which has for months supplied the cities of South Bend, Laporte and Elkhart with service, closed the exchanges in each of those cities which are now without telephonic connections. This was done in compliance with an injunction granted by Judge Blodgett in the suit brought against the Cushman people by the Bell Company. The Cushman Company was the most bumptious of the litigants which the Bell Company has fought.

*** "The long-distance telephone is much more successful than we had hoped it would be," remarks General Manager Uline (of Albany) of the Hudson River Telephone Company. "It is very expensive, from a popular view, because it costs $1.50 to talk over it five minutes. Yet every day there is an increase in patronage. We can talk with New York, Buffalo, or Boston as successfully as on short lines in Albany. We are putting in four new toll stations for the system in Albany. I find that the long-distance lines are used more by drummers than any other class of business men. A commercial traveler will reach Albany, for instance, and after looking over the city will call up his house in New York or Boston, and after describing the condition of trade take his instructions as to what he shall do from headquarters."

*** The toll business of the M. & K. company has grown so that the company has found it necessary to put in a new toll line board. It was made right in Kansas City, too. Downey Livingstone, carpenter, and Albert Barratt, electrician, were the makers, and they have every reason to feel proud of their work, and no doubt are, although their modesty keeps them from showing it. Superintendent Smith, however, expresses his pride in the mechanism in no unstinted terms. It is not only neatly put together and firmly made, but elegance and beauty were also aimed at and reached. It also possesses several improvements over the common toll line board, due to Mr. Barratt's electrical cleverness. One is the use of double jacks, which lessens the time required to make a connection just about one-half of what is required by the common board, while it also prevents much confusion and many mistakes. The board is equipped for 30 toll lines, and will begin operations with 12 lines. The two metallic circuits between Kansas City and Topeka, and Kansas City and Liberty, are connected with the board.

*** The Allegheney Central Telephone Exchange has regular Vassar girls in its employ. Recently, a Pittsburgh *Commercial Gazette* reporter asked Allegheny for Riverside. "All right," said the silvery voice.

"Of course it's all right," answered the newspaper man.

"You can bet it is," replied the S. V.

"I know it."

"Of course you do."

"That's right; you wouldn't be a woman if you didn't have the last word."

"That's a highly original remark."

"A little chestnutty but quite true, and in this case *apropos*. There's a good word for you.

"I have heard it before."

"Yes, you have!"

"Bet your life. I can speak French."

"Indeed! *Comprenez vous, mamzelle?*"

"*Oui. Je comprenez, monsieur. Je*——"

and then the whirr of the wire became terrific. A mixture of French and wire music came floating in with a force that sent the reporter to the floor senseless, and aroused the Ancient Mariner in the business office to such a pitch of frenzy that he grasped the receiver, and, bracing himself, shouted; "The Pentitentiary, quick! That stuff would kill anybody." A little more of the "silvery laugh" and the old mariner was told to "cut loose; Riverside was waiting."

*** The New Haven *Palladium* is happy over its new long distance telephone. Hear the editor sing: "The development of the telephone service still continues with wonderful strides, and perfection in many directions has already been attained. In every instance where a marked improvement has been achieved, the policy of the Southern New England Company has been to extend the benefits to all subscribers as soon as possible. A long distance transmitter was placed in the editorial rooms of the *Palladium* a few weeks ago, and is found to obviate many former annoyances besides making the telephone service far more valuable than ever had been. Shouting is now a thing of the past, there is no induction from light and power wires, and the best results are obtained when the tone of voice is very much lower than that used in ordinary conversation, a whisper being all that is necessary in talking to the central office, and, in most cases, in talking anywhere in the city. The instrument is so sensitive that conversations with people in any part of the State to which metallic circuits extend can be carried on in a voice so low that the words cannot be understood by people within 10 feet of the sender, and the same is true in talking to New York, while a very little increase of sound is necessary in order to be heard in Buffalo, 500 miles away.

Liabilities of Telegraph Companies.

Judge Baker, of Chicago, has delivered a decision on a motion for a new trial by the Postal Telegraph and Cable Company, in a suit brought against it some time ago by C. L. Lathrop & Co. The latter sent some dispatches to their correspondents in New York, in regard to the purchase of a large quantity of coffee. The telegraph company, it was claimed, made some mistakes in the transmission of the dispatches, through which Lathrop & Co. lost $8,000. They began suit against the company and recovered a verdict for $6,698, and the telegraph company thereupon entered a motion for a new trial. They set up that their printed message forms contained a notice of exemption from liability, and that on that ground alone a suit against them did not lie, and the verdict therefore was improper. It was also urged by them that the transactions of the coffee merchants were in the nature of gambling transactions, and hence damages were not recoverable. Judge Baker overruled these points and refused to grant a new trial.

An appeal was taken to the Appellate Court by the telegraph company.

The Newport Exchange Absorbed by the Providence Telephone Company.

The Providence Telephone Company has absorbed the Newport Exchange bringing that city into direct communication with Providence at no extra charge. With the growth of the Providence Exchange, new and improved instruments have been continually put in, but the most important improvement has been the introduction of the multiple switchboard system which Newport will now get the benefit of. The Providence system now includes eleven exchanges in its circuit, the cities of Providence, Newport, Pawtucket, Woonsocket and the towns of Bristol, East Greenwich, North Attleboro,' Attleboro', Warren, Pascoag and Westerly. These also cover and make it possible to communicate with Apponaug, Ashton, Barrington, Blackstone, Buttonwoods, River View, Central Falls, Centerville, Chepachet, Chartley, Mass.; Clayville, Georgiaville, Greenville, Harrisville, Hope Valley, Hopkinton City, Londsdale, Manville, Natick, North Scituate, Oakland Beach, Oakland, Pawtuxet, Phenix, Plainville, River Point, Silver Spring, Valley Falls, Watch Hill, Wickford, Wood River Junction and Woodville. Newport subscribers have heretofore been obliged to pay tariff rates to communicate with any of the ten exchanges mentioned and additional rates to speak to any of the places in the latter list. They will now have free commuication with the exchanges and but single rates to pay on the others. More advantages than these will accrue to Newport by the cheapening of the rates.

Major Martin and the Telephone.

I remember, says a correspondent, that the Major (Martin, the Texas blow-out-the-gas Congressman) was very nervous about the time that the nominating convention met in his district. Several wicked wags among his Congressional friends availed themselves of his nervousness at that time to work off a little practical joke upon him.

The Major's acquaintance with the telephone was then very recent, and his waggish colleagues had little difficulty in persuading him that the telephone in the House lobby had been connected with his nominating convention, or that Colonel Smith, his especial friend in the convention (of whom he had spoken rather freely), was at that moment anxious to talk with him. Inasmuch as he didn't understand "how to work the new-fangled thing" one of his friends volunteered to conduct the conversation for him.

"Major," he said, "Colonel Smith says that your rival, Judge Jones, is making great headway with the delegates, and that it would be well for you to let them know through him just how you stand on pending public questions. For instance, they want to know how you stand on the 'fisheries question.'"

"What for?" demanded Martin. "There aint any fish in my district," which serious reply seemed so comical to the practical jokers that they could hardly proceed for laughter. They stuck to it though until they had defined his position upon every question of public interest, and a great many questions which are of no interest whatever. Martin had never heard of most of them, but he answered just as well as most of the fellows who have could have done.

When they were weary with laughter the humorists told him that Colonel Smith thought his renomination and re-election were now assured, which prediction subsequently came true. The Major has always had a great liking for telephones ever since.

The employés of the Mutual Union Telegraph Company, Boston, presented Mr. James H. Burke, the chief operator at the main office on Milk street, with a handsome gold chain and charm. Mr. Fred. Hutchinson made a brief presentation address, and highly complimented Mr. Burke on his ability, and the efficiency with which he discharged the duties of his office, and spoke of the esteem and honor in which he was held by those under his supervision. Mr. Burke responded briefly, and in a few appropriate words thanked the donors for their gift.

Mayor Hewitt's Opinion of the Electrical Subway Work of New York.

In speaking of the work of the Board of Electrical Control, in reviewing his administration just ended, ex-Mayor Hewitt comments as follows:

"At the outset of my term of office I adopted the principle of calling together the heads of department to consult as to the legislation which might be required for the advantage of the city and the better conduct of its business. Every act proposed was carefully considered by this conference. One hundred and ninety-one bills directly affecting the city of New York were passed during the last year. The passage of many objectionable bills was thus defeated, but in some important cases the Legislature acted directly against the recommendations of the city authorities. The Commission for the Construction of the Electrical Subways was thus organized against the unanimous protest of the city officials who had recommended the addition of the Mayor, Comptroller and Commissioner of Public Works to the commission, but the latter two officers were omitted.

"The consequence has been that the work has gone on in a manner which has been exceedingly destructive to the use of the streets, and the result is believed by many competent experts to be an entire failure. The only consolation is that it is not paid for out of the city treasury. The importance of burying the electrical wires is so great that it is to be hoped that some means may be found of making the existing conduits of use in order that the improvement may not be indefinitely postponed."

Telegraphy in Spirit Land.

COMMUNICATION BY MEANS OF THE MORSE CODE WITH DEPARTED FRIENDS.

The spiritualists in this city are about to introduce a new wrinkle or two into their methods of communication with departed souls in the other world. Rapping was found too slow, and slate-writing, the most popular method with mediums, has grown tame. The messages are now sent by spiritual telegraphy, through the hand of the medium, and are delivered from a telegraphic "sounder." This form of communication has recently been introduced in Cleveland, O. The "sounder" is an ordinary one, such as is used by soulless telegraphic corporations. The medium's hand is held over it, and as the spirits move the fingers they strike the key. The tedious old rapping alphabet will be dispensed with, and the Morse alphabet substituted. A little five-year-old boy in this city, who is regarded as a great medium, will work the telegraphic instrument here. A prominent spiritualist, who was asked how the spirits became acquainted with the Morse alphabet, replied that many of them knew it before they went over, and they taught the others.

Healthiness of the Electric Light.

Electric lighting, as a means of preserving and promoting health, has not been sufficiently appreciated by the British public. It may safely be said that electric light is the only form of artificial illumination which is not injurious to health. This is a strong argument in favor of the general introduction of the electric light; but it is when we begin to compare this light with that of gas, or any other artificial lights, that its beauty, purity, brightness, and cleanliness, and safety come out in strong contrast. Gas not only consumes and pollutes the air, but is very poisonous, besides having a deleterious effect on the furniture and decorations of our homes. Gas gives off a certain amount of soot, which is evident from the blackened ceilings and cornices, discolored wall papers, etc. The destruction to goods in the shops of our great cities from the action of gas must also be very great. In offices, shops and factories employés can use it continuously without feeling the lassitude, headache and fatigue which are frequently caused by the use of gas. As a means of retaining health its advantages are indisputable. It has been said, with a considerable degree of truth, that every hour a man spends in a room lighted by gas, tends to shorten his life and abridge his powers of work. The electric light is a pure, healthy light, which, if no other light were used, and the smoke of our fires self-consuming, would leave our cities almost as fresh and bracing as a Highland hill; and rosy, instead of pale cheeks, and brightly-flashing, instead of dim, lusterless eyes, would mark the city inhabitants.—*Health.*

The First Telephone.

BELL'S WORK ON IT AND HIS EXPERIMENTS WITH IT.—THE TELEPHONE IN THE TROPICS.

"This is the first Bell Telephone ever made," said Charles Williams, Jr., of Somerville, to a Boston *Herald* reporter. "Every telephone made bears its number, but this is old No. 1." He brought it in lovingly and set it on the table.

It was a box of black walnut, and looked like the cover of a sewing machine, but was somewhat smaller. Protruding from one end was a flaring woolen mouthpiece, nearly three inches in diameter. Mr. Williams lifted the lid. There lay a big horseshoe magnet about five inches long. The diaphragm of thin metal which was fastened over the hole where the voice entered was nearly five inches across. Some wires ran out through holes in the bottom of the box. There was no receiver hanging on its back, no crank to turn, no bell to ring—nothing but this box that lay flat on the table.

"Bell came to my shop to do his experimental work," said Mr. Williams, who was at one time in the electrical manufacturing business at 109 Court street, Boston. "After he made the telephone I strung a wire from my shop out to this house, about three miles, and took this telephone out here. We had another in the shop, and when he was ready to call the attention of some one at this end he tapped on the diaphragm with a lead pencil. That was the first way of signaling. The old telephone worked very well indeed. It lay on a shelf put up against the wall at such height that I could speak into it as I sat in a chair facing it.

"Not long afterward we ran a wire up to Music Hall, in Boston, and gave a public exhibition. We had a cornet player and a quartet here, who played or sang standing before a funnel-shaped arrangement that gathered the sound into the telephone. Bell was in Music Hall. He opened with a lecture on the telephone and then tapped on the diaphragm of the instrument. There was a big audience, but it was so still you could have heard a pin drop. The cornetist in Somerville played "Hold the Fort" or something of that sort, and everyone in Music Hall heard it. And the cornetist in Somerville heard the applause. Questions were asked and answered over the telephone, and the quartet sang and the cornet was played till everybody was satisfied.

"I made all of Bell's telephones for a long time. Almost every batch we turned out was an improvement over the preceding ones; that is, they were smaller and handier. Then we made a hand telephone, that looked something like the present receiver, only it was of wood. You spoke into it and then held it to your ear for an answer. Some people wanted two—one for each hand. They talked into one and listened at the other. Others had both a hand telephone and a box telephone. Afterward came the Blake transmitter, the magneto-bell and the other devices that make up the telephone of to-day.

"The first telephones we put in were on private lines running from business offices to workshops or residences. The first person to have a telephone put in was Frank Downer, banker, of 28 State street, who connected his office with his home on Winter Hill here in Somerville.

"There was no such thing as a 'central' then, and C. T. Holmes, who was in the burglar alarm business, and who had telephones to several banks, conceived the idea of connecting them up by something like a telegraph switchboard, so that one bank might speak with another. That was the first 'central.'"

Then Mr. Williams lugged his precious telephone away.

"There's no part of the civilized world where the voice of the telephone is not heard," said James H. Howard, the general manager of the Tropical-American Telephone Company. "In Buenos Ayres there are more telephones according to the population than there are in any other city in the world. There are four 'centrals' in Buenos Ayres, one for dealers in hides, one for dealers in wool, another for all other dealers, and a fourth in the residential section. These, of course, can be connected up. This arrangement might strike people here as odd, but it is found most convenient there.

"The American Bell Telephone Company, you understand, controls only the business in this country. Our company, which bought from Bell and his partners, has the sole right to Central and South America and the West Indies. Similar companies control the business in Great Britain, on the Continent and in the far East. All our telephones have a bright red band around the receiver.

"Rates in South and Central America are much less than in the United States. Our purchase was outright, and there are no royalties to pay nor restrictions of any sort. The cost of maintenance, too, is much less.

"But the one thing that has most to do with the success of the telephone in the tropical countries is the heat itself. Take it in Caracas and La Guayara. There it is so hot during the middle of the day that no one ventures on the street except through necessity, and if there can be a greater blessing to the people of such a city than the telephone I'd like to hear it mentioned. Orders for all household wants are given, business is transacted and friendly calls are made, all by telephone. Every city of any size in the tropics has the telephone, and a place without it would not be desirable to live in."

A Bill to Reduce Telephone Rental in New York State.

Assemblyman Hamilton has introduced a bill in the New York Legislature, providing that all corporations, companies, associations, societies, firms or individuals, incorporated or unincorporated, who are now, or may be hereafter, engaged in the business of supplying telegrapic communication in cities and incorporated villages of this State, shall furnish to each and every person applying, subscribing and paying therefor (whose residence, office or place is within the district served by any such corporation, company, association, society, firm or individual), a telephonic communication and connection, together with such instruments and electrical apparatus as shall be necessary to transmit vocal messages, in cities of 500,000 inhabitants or over, at and for a charge and price of not to exceed $6 per month for such service, and in all other cities and incorporated villages of this State, at and for a charge and price of not to exceed $3 per month. Any corporation, company, association, society, firm or individual affected by this act, or any officer, agent, servant or employé thereof, who shall wilfully violate any of the provisions of this act, shall be guilty of a misdemeanor, and shall be punished accordingly, and shall also be liable in a civil action for damages to the person aggreived. Any such person or company violating any of the provisions of this act shall also be liable in the sum of not less than $50, nor more than $500, in the discretion of the court, for each offense, recoverable at the suit of the people on the relation of the Attorney-General, who shall bring an action for the same in behalf of the people of the State of New York, and the amount recovered in said action shall be paid one-half to the State Treasurer and one half to the County Treasurer in the county where such action may be brought.

Now let the bill to regulate telegraph rates, electric light rates, the price of meat, "electric" sugar, canned beans, etc., etc., be heard from.

An Aged and Historical Telegraph Pole.

The wire-bound pole of the Western Union telegraph on the corner of Broadway and State street, Albany, N. Y., which has held from 90 to 100 wires since planted, nearly 20 years ago, was supplanted by a new one somewhat taller, one day last week. The average life of a telegraph pole is about 10 years, depending on the nature of the wood and the soil. The pole removed had been braced up several times by strands of wire. When the hole was dug for the original pole, the owner of the building opposite objected, and jumping into the aperture refused to allow the men to proceed with the work. The owner was allowed to stand in the hole several hours, and then Sunday morning the telegraph men came around and planted the stick without molestation.

The Telephone.

(From the Cincinnati Enquirer.)

As I sit and idly ponder,
"Will she telephone to-day?"
And my thoughts obedient wander
To a charming little fay.
Then I hear a sudden ringing,
Ringing at the telephone,
Now the tidings it is bringing,
Bringing for my ear alone—
"Hello! who wants Mr. Shillin?"
"'Tis I, your tailor, Mr. Shears.
Already twice I've sent my bill in,
And your account has run two years."
HELLO! HELLO!! HELLO!!!

Submarine Telegraph Extensions.

Interruptions of telegraphic communication with Australia, owing to volcanic eruptions and other causes, have induced the Eastern Extension Telegraph Company to lay a third cable from Banjoewangie to a point in Western Australia, probably somewhere near Beagle Bay. The length of the new cable will be over 1,000 miles. The Telegraph Construction Company are working night and day loading this cable into their ship, the "Seine," which is to leave the Thames on Wednesday next, to lay the cable. Mr. C. Riddle is the engineer in charge, and Mr. Thomas Clark is the electrician in chief. The Eastern Extension Company believe that when this cable is laid, the chances of any breakdown in telegraphic communication with Australia will be very remote. Another great cable of 700 miles is now being made by the Silvertown Company, for connecting Loando with Mossamedes, on the west coast of Africa; while the Telegraph Construction Company are making a cable of 1,500 miles to connect Mossamedes with Cape Town. This work will be completed in March next, and thus there will be two telegraphic routes to South Africa, one *via* the east and the other *via* the west coast—an important boon in the event of any grave crisis again arising in that quarter of the world.—*London Electrician.*

Telephones vs. Motors.

An important test case was filed in Common Pleas Court at Akron, Ohio, last week. Its title is the Central Union Telephone Co. vs. the Sprague Electric Railway and Motor Co. and the Akron Street Railway Co. The plaintiff states that it is injured by the defendant in these particulars: The subscribers to the telephone exchange are frequently debarred from asking for any telephone service by the derangement of the signaling instruments at the central office. The call bells on the premises of subscribers are often rung by false signals. Loud and interfering noises are produced in the plaintiff's central office and on many of the wires connected therewith. Plaintiff asks that defendant corrects its arrangement of wires and imperfect manner of disposing of its current and for other equitable relief; also that defendant be restrained from constructing any more lines of street railway in Akron until the final determination of the case. The action is brought by A. A. Thomas, the Chicago attorney of the telephone company, and E. W. Stuart, of Akron. The result of the case will be watched with interest.

.... A telegraph operator in Minneapolis has invented a word counting machine which may be used by itself or attached to a type writer. It is much the same sort of thing as a pedometer, only it is more accurate. It is as large as a small clock. The works are inside the nickel case, on one side of which is the face. The machine will count up to 2,500 words, and can be used for any number by keeping tally of the number of times it passes the 2,500 mark.

.... A. G. Safford, an old military telegraph operator, recently moved to Washington from St. Albans, Vt., and opened a law office at 1311 F street. He devotes his spare time to electric inventions. He has a new telephone of novel and practical design, with nothing whatever to hinder its becoming a financial success (except the Bell patent), and a street railway system, said to possess some strikingly original and valuable features, the details of which are not ready for publication.

TELEGRAPHIC

.... The Quincy, Mass., telephone subscribers are complaining of the poor service, claiming that the electric light currents disturb them.

.... John J. Moore, who built the Mutual Union Telegraph lines, and has a fortune of from $2,000,000 to $3,000,000, came to New York not many years ago with only $30 to his name.—*Evening World.*

.... The Postal Telegraph Cable Company have established a construction headquarters at Atlanta, Ga., and are making preparations to begin construction work between here and Augusta, and between here and Birmingham, Ala. They say they will use large cedar poles and all wires to be copper.

.... The Mackay-Bennett Telegraph Company has a force of men at work running a new line from Alameda, Cal., to Los Angeles. They are now preparing the poles which are being hewn out of redwood piles, and will be considerably larger than ordinary telegraph poles. The line will run to Niles and continue over the mountains to San Joaquin Valley. Two copper wires will be stretched upon the poles.

.... It is generally believed by the telegraph operators that at some time in the near future the Western Union Company proposes to adopt the Wheatstone system of telegraphy, to the almost utter exclusion of the Morse system heretofore chiefly used. By the Wheatstone system four or five hundred words per minute can be sent by one operator. This is more than ten times as many as can possibly be ticked with the old Morse machines. Experts say the new departure is calculated to revolutionize telegraphy in so fas as it will enable any company to transact its business at about one-half the former cost. There will be nothing in the nature of an experiment in the change, because the Wheatstone system has for a long time been in operation between New York and important long-distance points.

.... Papers were served in an action on behalf of Erastus Wiman's telegraph company, the great Northwestern against the Montreal Telegraph Company at Montreal last week, asking the Superior Court to fix a reduction of rental paid to the latter. The basis of the action is the failure of the Montreal company to maintain the Northwestern company in peaceable and exclusive possession of lines, routes and rights of way on independent railways included within the original lease, but subsequently incorporated by the Canadian Pacific into their system, and more recently usurped for public telegraphic purposes. A peculiar clause in the Quebec code relating to landlords is relied upon to force a reduction in proportion to the damage suffered, which if applicable to the future is also retroactive in its effect.

A Novelty in Telegraphic Systems.

A recent patent issued to M. W. Dewey, of Syracuse, N. Y., shows an interesting adaption of the multiplex idea. With four transmitters and four receiving magnets, one operator transmits the messages at high speed by a species of electric stenography. The four receivers operate separate markers arranged in a line transversely of the paper ribbon, and by the grouping of the signs the letter or symbol is determined. The operator has the four transmitting keys conveniently arranged under his eye, similarly to the keys of the now familiar stenograph. The depression of one or more of these causes like movement of the corresponding markers at the distant station, and dots and dashes are made by the time element as in the Morse system. By diplex or multiplex arrangements, only one wire is necessary for the work. The idea is ingenious and may find a useful field.

* * Holmes, Cummins and associates, at Memphis, Tenn., will build an electrical railroad, and have about closed contract for outfit with the Sprague Motor Company.

* * The McGavock & Mount Vernon Horse Railroad Company, Nashville, Tenn., will operate their road with electrical motors, and have contracted for outfit with the Thomson-Houston Electric Company, of Boston, Mass.

* * The Chattanooga & Highland Park Electric Street Railroad Company, Chattanooga, Tenn., have purchased a controlling interest in the Mission Ridge Incline Railway and will equip that, also, with electric motors.

* * Des Moines is becoming quite an electrical city. It has an abundance of electric lights. It has an electric railway which is successful and extremely popular, and will rapidly supersede all forms of street locomotion. The *Register* is becoming electric also, and is now printed by electricity. All the *Register* presses are run by electric motors, and we are able to say to the world that it is good, cheap, and satisfactory in every respect.—*Des Moines Register.*

* * J. H. Bunnell & Co. are building a number of the Eickemeyer electric motors. The *Morning Review*, published at Spokane Falls, Washington Territory, says: The motive power for the *Review* is furnished by a three horse-power Eickemeyer motor. This little machine is encased in a cast iron box about 14 inches square, and with belt pulley does not occupy a space larger than an ordinary gripsack. The boiler and engine formerly in use has been relegated to "innocuous desuetude." The *Review* will now be run off with lightning speed, necessary to keep up with the times and the large increase in circulation

That always interesting and usually well informed journal, *The Railroad Gazette*, has an article on "Car Lighting," in which a slight error mars what otherwise would have been highly instructive reading. We quite agree with it that a good light is economical because it brings passengers, and also that the electric light is cleaner and steadier than any other. But when it says that the light is yet in its experimental stages, we leave the main track, on which both of us have been gliding so smoothly, and are side-tracked in surprise at so careless a statement. If it is true that what may be improved upon is only in its experimental stages, then electric lighting is in that condition. But so is railroading, editing a newspaper, preaching the gospel, making a cheese, and everything else. As to car lighting, we would inform our E. C. that electric lighting is a practical, every day, or rather, every night, success. It need have no fear of recommending it; a number of special trains throughout the country now using it, notably the New York special on the Boston & Albany Railroad, whose plant, recently examined, was shown to be as good as when first used, now two years ago.

Who is to be the first murderer to come forward and submit himself to the electric death blow? Don't all speak at once. It is suggested that the condemned individual be so placed that the shock he gets will be that of the extra current produced by a large coil around a heavy iron core. As the effect is popularly known as the magnetic "kick," it might well be said, after death, that the criminal was electrically kicked out of this world.

A New Electric Railway at Nashville.

The Thomson-Houston Electric Company has just closed a contract with the McGavock and Mt. Vernon Street Railway, of Nashville, Tenn., for the equipment of a part of its road. The length of the line is 3.07 miles, of which 2.30 is double track, and .77 single, making a total length of single track 5.37 miles. There are seven curves on the line and numerous grades, the maximum being 5½ per cent. There will be six cars, each 16 feet in length, and capable of carrying 75 passengers, and equipped with two 10 h. p. Thomson-Houston motors. The overhead system will be used. This contract was not entered into until all the various systems now in operation in the United States had been carefully investigated. Electricity will not be used on the entire line at present, but a loop from Cherry street around by the Public Square back to the stables. The time consumed by a car making this trip is 70 minutes. The new car will make this trip in 30 minutes. The consideration of saving one-half of the time is a material one viewed from both the standpoint of the company and the patrons of the road.

Eight cars are now used on this division, and as the motor cars will be twice as fast, only four of them will be needed; but for the fact that the company expect an increased patronage, so that the six cars will be put on as soon as ready. The City Council some weeks ago granted the right to exchange animal for electrical power to all the street railway companies, and if the present road proves as successful as other roads operating this system, the remaining branches of the McGavock and Mt. Vernon road will be equipped, and it will, in all probability, be adopted by the East Nashville and South Nashville companies. The company has also closed a contract for the equipment of two miles of single track at Southington, Conn. The overhead line is all completed except the curves, which are now being put in. The bracket method of suspension is used except on the curves, where the cross suspension is employed. The cars will be operated, each being equipped with two 10 h. p. Thomson-Houston motors.

The Electrical Resistance of Iron.

In text books the resistance of commercial iron is generally given as 6.56 times that of copper, but according to the results of recent experiments made by Mr. W. H. Preece, F. R.S., it is actually only 6.034 times that of copper. The exact determination of the resistance of iron is of considerable importance, especially now, when through the operations of the copper syndicate the price of this metal has been forced up to a figure which precludes its use for many electrical purposes. The following table, which we extract from a recent post office circular, gives the specific resistance of various metals. The resistance in C.G.S. units of a cubic centimetre at 60°F. is as follows:

Silver	1609
Copper	1642
Pure iron	9753
Commercial iron	9907

The increase of resistance with temperature from t to t_1°F. for iron can be determined by the formula.

$$R = r\,(1.0027)^{t_1 - t}$$

where r is the resistance at $t°$ and R at $t_1°$. If the temperature be given in centigrades, the formula is

$$R = r\,(1.0048)^{t_1 - t}$$

For telegraph lines, "low" and "high" resistance iron wire is now used, the former being either charcoal iron or a special blend, and the following table gives the mechanical properties of these wires:

Gauge No.	Weight per mile.	Diameter.	Breaking weight. Low resistance. Blend.	Breaking weight. Low resistance. Charcoal.	Breaking weight. High resistance.	Elongation per cent. Low resistance. Blend.	Elongation per cent. Low resistance. Charcoal.	Elongation per cent. High resistance.
	Lbs	In.	Lbs.	Lbs.	Lbs.			
6	600	0.209	1920	1725	2100	16-17	16-17	17-18
7½	400	0.171	1280	1150	1390	"	"	"
10½	200	0.121	640	575	693	"	"	"

The Boston Electric Club.

The new board of officers of the Electric Club, Boston, were installed last week. President W. J. Denver made an inaugural address, and confidently prophesied on the future growth and prosperity of the club, with some suggestions on its future management. The treasurer made an exhaustive report, showing the financial status of the club to be most satisfactory. The house and entertainment committee for the ensuing year will consist of Messrs. J. C. Wilson, John Post, Jr., E. H. Hewins, O. K. Stuart, J. R. Lovejoy, W. C. Woodward and A. B. Griggs, and the membership committee will be Messrs. G. B. Neal, Edward Blake, S. E. Barton, G. W. Mansfield and J. T. Moriarty.

*** Our exchange says that Mr. E. A. Saunders, of Naugatuck, wished a few days ago to call a doctor over the telephone. The operator at the central office said, after trying, that the doctor would not answer. Later Mr. Saunders tried again and heard the operator say "He is after the doctor. Let the——fool ring." Once more he tried, remarking that he had been ringing for half an hour. The retort was: "You're a liar." Mr. Saunders then brought suit against the Southern New England Telephone Company for neglect of duty and abusive language. Operator Quinland denied having used such language, but Justice Gibbons to-day found the company guilty, and imposed a fine of $100 and costs. This sort of service does not often occur, and it is probable that this particular operator is now shoveling coal or doing other manual labor that he is qualified for.

The Armington & Sims Engine Company reports an increase of 75 per cent. in the volume of its business as compared with 1887. This enterprising and flourishing concern moved its establishment to the Paine & Sackett mill estate on Eagle street a year ago, the business having grown beyond the capacity of the old location on High street, and already has been compelled to increase the capacity of the new plant by the erection of a new building covering 10,000 feet of ground, to provide room for additional heavy tools for making special parts of the engines and to make a general increase of equipments. The product has been one engine a day, averaging 100 horse-power each, and throughout the year the company has been from 90 to 100 engines behind in delivery of orders. It was intended, when the Eagle street establishment was secured, to extend the business by the manufacture of large engines for manufacturing purposes, but the concern has been so driven with orders for engines to supply power for electric lighting that it has been impossible to make anything but engines for this branch of work, and many orders for mill engines, received without solicitation, have been rejected. Several engines of this class have been turned out, and the management feel assured of a good oportunity for profitable enlargement of the business by future efforts to supply the demand. The average size of the engines has been steadily increasing during this year. This establishment has large government contracts for engines to supply power in the Ordnance Department at the Washington navy yard, and for furnishing power to light new and old cruisers by electricity, every vessel in the navy that is so lighted having an Armington & Sims engine for the purpose. There are double engines of high speed and to couple directly to the dynamos. Twenty engines, small in size, but to furnish 450 horse power at 150 pounds steam pressure are now being turned out for the Edison central lighting station in Philadelphia, and two large stations in New York city are being provided with engines. A large foreign trade has been secured and during the year orders for engines for electric lighting in Milan, Italy, have been filled. The Italian parties were recommended by Armington & Sims to procure their engines from the factory in Leeds, England, but they insisted on securing them from the Providence establishment, for they believed they got better made engines, and Armington & Sims found they could lay down engines in Milan cheaper than they could be placed there by the English makers of the Armington & Sims engines. The working force has been increased and now numbers over 200 men.

Electric Lighting in San Diego, Cal.

The San Diego *Union* in its New Year's edition gave a very interesting summary of the electrical interests of San Diego. It gave the following description of the arc lighting system of the San Diego Gas and Electric Light Company:

The dynamo room of the building now occupied is 90 by 45 feet, and in it is placed the 300-horse power Hamilton Corliss engine, one 60-horse Buckeye engine for the mast lights, seven 30-arc light Jenney dynamos, one 100-light Jenney incandescent dynamo, and one 30-arc light Western Electric dynamo bought by Mr. Babcock for lighting the Hotel del Coronado during its construction. The current was carried through about two miles of line wire, and under the bay through about 7,000 feet of Kerite cable. The machine has not been used, however, since the installation of the 60-light arc plant at the hotel. With a scaffolding that can be made at any time, floor space for 28 dynamos is provided in the new works of the company. In an adjoining portion of the building is the boiler room, 45x50 feet, in which are two 150 horse power boilers, while near by is the 100 foot brick chimney, so situated that a steam battery of ten times the present capacity can be built around it. The company is at present furnishing 110 commercial arc lights and 60 city lights, distributed on ten 120 foot iron masts. The cost of the entire plant was $90,000, and is under the able management of L. M. Vance.

A few days before the Westinghouse incandescent installation was completed, the Jenney people received an incandescent dynamo that had been ordered some months before, and they are now serving customers with 20 candle power incandescent lamps. The system is known as the Jenney series system, and the light given is particularly brilliant. The company proposes to have 300 more lights of the same description in operation before the expiration of 30 days, as the plant for the same is now on the way from Indianapolis.

Book Review.

Twenty Years with the Indicator.—Pray. Vols. 1 and 2; (one volume), Seventh thousand, large 8 vo., 285 pp., many illustrations. John Wiley & Sons, 15 Astor Place, New York. Price, $2.50.

The *raison d'etre* for this new edition of a very popular work is the growing demand for it, as for other books of a practical character so written as to be perfectly intelligible without the complex formulæ that stagger the aspiring student engineer who wishes to learn all he can about his engine and boiler, but does not want to arrive at his goal only by wading knee deep in the quicksands of calculus and trigonometry. Mr. Pray long ago recognized this truth, and has given us a book which can be read and understood by any steam engineer of fair intelligence, and it ought to be on the shelf of everyone who desires to know the whys and wherefores of his engine, and how to get the greatest economy in its performance.

It is impossible to read this book without acquiring a vast amount of insight into the real nature of the functions of a steam engine in all its parts. Even to those who think they know it all the book will be useful and enjoyable. Electric light engineers especially should read it and study it carefully, and the labor will well repay them. Almost every known type of engine is discussed in a most practical way by direct analysis of actual diagrams obtained by the author in his own experiences as consulting engineer. We commend the book to every one of our readers who have not already procured it.

Mining Machines Operated by Electricity.

The advantage of using electricity, its simplicity, compactness, safety, cleanliness, and reliability over the use of steam for power were early recognized by mining engineers, and electricity is now generally regarded as the most convenient agent at the miner's disposal for transmitting his power into the interior of the mine.

One of the newest and latest applications of electric power to mining work can be seen daily in operation at Mr. T. C. Heimes' "Drane Colliery," near Osceola, Clearfield County, Pennsylvania. Here a most interesting application of motors for mining work has been devised by Mr. F. M. Lechner for operating a coal-cutter by electricity.

Mr. Lechner is well known as being not only the first inventor of coal-cutting machinery, but also the first to operate compressed air in mines for this purpose. His long practice and experience in the coal mining field has made him familiar with all the difficulties attending the use of machinery in mining work, and ever since electric power has been in use for industrial purposes, he has made a study of the problems in adapting electric power to this work.

It soon became evident to Mr. Lechner that the best results could only be obtained by operating the motor and cutter apart, as otherwise the size and weight of the cutter, with the motor mounted upon it, would prevent its easy transportation in the mine.

In order to do this, the following arrangement has been adopted in the mine before mentioned, and has proved very successful.

The motor, which is a 10 horse-power of the Sprague type, is mounted upon a truck running upon rails, so that it can be very easily handled, and hauled from one position to another as occasion requires. The entire weight of the motor is less than 1,000 pounds.

The cutter operated by the motor, which in this case is the "New Lechner," is set in position in the room to be cleared, and is connected with the motor by a five-eighth-inch rope belt, running in V-shaped grooved sheaves, one being on the motor and the other on the cutter.

This connection is long enough to allow the motor to be operated 30 feet away from the cutter, and has been set in a position in this mine 1,600 feet away from the dynamo. The motor is held in position by guys at the point of use.

By means of screw jacks that can be easily adjusted to any height with loose sheaves upon them, the cutter can be operated at any angle from the motor, and the connection is made taut by moving the truck upon which the motor rests, and securing it in the right position by guys.

All mining engineers are familiar with the difficulty attending the working of the cutters in the limited space generally allotted them in mines, and how essential it is to have every machine divested of every pound of surplus weight.

They also know what care must be exercised in moving it with great iron crowbars, to prevent injury to the more delicate parts of the engines, and however careful, how frequent it is that connecting rods and other parts are so impaired that the machine has to be sent to the shop. Then how the rugged action of the engines shake everything loose on the machine, however firmly they may appear to be adjusted. All this is removed by the absence of the engines, the machine running as smoothly as a buzz-saw, and as a consequence, cutting with the same facility. By this plan, three machines can be operated by one motor, for when one room is cut, the motor can at once be hauled to another room, where a machine is in readiness and position, cut that room and pass to a third while the coal is being removed from the first two, and the cutters being again placed in position.

It was found upon a preliminary trial of this apparatus at the Osceola Mines, that by its use two men are able to excavate 100 tons in 10 hours, and that they can move the cutter as often as desired without any auxiliary aid.

The efficiency of both dynamo and motor is over 90 per cent., so that, allowing 10 per cent. drop on the line, nearly 73 per cent. of the power delivered to the dynamo pulley can be depended upon at the motor for work.

It has been estimated that the cost of equipping a mine for the purpose of operating machinery with electricity, is only about one-half the cost of equipping it with compressed air, and the price of maintenance shows about the same proportion of saving.

Photographing Bullets by the Electric Light.

The plan of Mach, the Austrian chemist, is to illumine the bullet by letting it break an electric current formed, but the velocity of the bullet must exceed that of sound, in order that the conditions of the air before and behind the projectile can be shown. After various experiments he succeeded in his efforts to photograph projectiles fired by Wernal and Jurde guns, having respectively an initial velocity of 438 and 530 metres per second. The photographs obtained in this manner showed an air formation in front of the bullet having the form of an hyberbole, while behind it almost a vacuum was formed, in which, when the initial velocity was very great, there were some curious spiral motions. From the description given, there appeared from these photographs to be a great similarity between the motion of a body through the water and that of a projectile through the air.

The Electric Light Bug.

Since electric lights were introduced in Georgia large gray bugs have become common. They are called electric bugs. The other evening John McLaughlin of Savannah was sitting by an open window and one of these bugs, about two inches long, flew in, and, striking the wall, fell to the floor. McLaughlin picked it up to throw it out of the window and the bug sunk its claws into his hand. He said the sensation was as though several fish hooks were being pulled through the arm. Immediately his hand began to swell, and small pimples appeared on his hand, arm and face within twenty-four hours. For over a week the hand and arm were very sore, and at one time the case looked dangerous.

—— The efficiency of the electric search light apparatus, as supplied to British war vessels, was recently exemplified in the Bombay Harbor by the gunboat "Mariner," which arrived there from the Seychelles. The night was dark, but the vessel was able to steam in to a point opposite the Apollo Bunder, where she made fast to an admiralty buoy. The flashes thrown out by the apparatus rendered Malabar Hill and the whole coast line distinctly visible from Colaba.

—— The companies in the electric light consolidation at St. Louis, mentioned in the REVIEW last week, are the Thomson-Houston, Brush, Western Electric and Metropolitan Electric Light. A dispatch from there says: "The prices have been cut so much during the last year that the companies assert they have not made a cent. The Thomson-Houston Company proposed a trust, and the other companies accepted the idea. It is given out that the Thomson Houston Company has purchased the controlling interest in the other four companies, but from other sources it is learned that the stock of the other companies is merely held in trust."

—— East Portland, Oregon, is supplied with 100 incandescent lights, furnished by H. A. Hogue, at a monthly rental of $3 each. He has a two years' contract on these terms, which are subject to alteration. If the city wishes to change the incandescent for arc lights after the expiration of six months it may be done by giving Mr. Hogue notice that such change is desired. The lights furnished are excellent. Very likely more than 100 will be required, as there are before the city council petitions asking for 10 more lights to be located in different portions of the city. To operate the lights a circuit of 12 miles is required. The cost of the plant was between $10,000 and $12,000. Mr. Hogue deserves credit for putting in the plant under discouraging circumstances. He will enlarge his facilities as the demand may require.

Electric Lighting in London.

The Board of Trade has refused all applications for licenses to construct and maintain systems of electric lighting in London, merely granting instead provisional orders whose operation may be terminated at any time. These orders must receive the further sanction of Parliament, and a clause to that end is in preparation, and will be embodied in the confirmation bill, and referred to a select committee. The duty of this committee will be to hear applicants and decide upon the merits of their claims and licenses.

—— At the Hoosac Tunnel, now lighted by electricity, it is said that the engineers can now see a mile ahead in the absence of fog, and work in the tunnel can be accomplished much more rapidly, and travel is rendered much safer by the electric light.

—— The committee on street lighting at Springfield, Mass., refuse to approve the electric light company's bill on the ground that the lamps do not furnish the stipulated candle-power. The measurement made them about 1,000 c. p. each, though 2,000 c. p. was expected.

—— Electric lights are wanted in the streets of Ashland, Pa.; either 30 arc lights of 2,000 candle-power each, or incandescent lights aggregating 5,000 candle-power, distributed in lamps of not less than 16 candle-power each. Frank Rentz, town clerk, has the matter in charge.

—— The Ft. Wayne Jenney Electric Light Company are running their new factory with full force and to show their marvellous despatch, succeeded in finishing and shipped one large and complete equipment of electric light plant in just three weeks from the time their old factory was burned.

—— The contract for lighting the streets of Lynn, Mass., the coming year, has been awarded to the Lynn, Gas and Electric Lighting Company for 46 cents per light for electric lights per night. There are 130 electric lights. By the new contract these lights will be kept burning till 1 A. M.

—— During a theatrical performance in Madrid, an accident occurred to the electric light plant and the lights went out. The audience also went out, and with Spanish wisdom compelled the proprietor to refund the ticket money. It would have paid him to have had his electric plant in order.

—— Lockport, N. Y., has discussed the question of owning its own electric light plant, and at a called citizens' meeting, after an animated discussion, appointed a committee to investigate. Messrs. E. W. Rogers, ex-Mayor Wm. Richmond and Alfred Morgan were appointed and will visit cities owning electric light plants and make a report.

—— The matter of the electric lighting for the streets of St. Johnsbury, Vt., has been settled by the ratification by the village of the contract with the Thomson-Houston company. This action made it useless to do anything further with the injunction brought by Judge Ross to restrain the trustees from acting under the contract and he has withdrawn the suit.

—— The Roaring Fork Electric Light Company, of Aspen, Colo., has recently sent in an order to the Brush Electric Company for one 60 to 65 light arc dynamo, together with a number of lamps for same. Not long since, two of the officers of the Muskegon Electric Light Company, of Muskegon, Mich., called upon the Brush Electric Company, of Cleveland, Ohio, and placed with them an order for a 45 light arc dynamo, current regulator, etc.

—— The Boston Electric Light Company have begun the moving from their Congress street lighting and power station to their new one on Atlantic avenue. The moving began last week and by the first of next month they expect to be moved in. After that they are to move from their Stanhope street station. In moving from the Congress street station 25 miles of new wire will be needed to lengthen the circuits. The estimate cost of moving will be $30,000 for each station.

ELECTRIC LIGHT NEWS

—— Electric lights inside of a month is what the citizens of Richmond, Kansas are hoping for.

—— Compressed air engines are to be used for operating the electric light plant in the Paris Bourse.

—— Miliana, a town in Algiers, with a population of five thousand inhabitants, has adopted electric lighting.

—— The Warner Iron Company, Goodrich, Tenn., want to purchase machinery for an electric light plant at once.

—— The electric light company of Terre Haute has been awarded a three year contract from February 1st, at $70 per arc lamp per year.

—— The Westinghouse Electric Company has secured the contract for lighting one of the suburbs of Rio Janeiro, the capital of Brazil.

—— The Board of Public Works, Nashville, Tenn., are asking an appropriation of $21,000 to light the new pumping station with incandescent lights.

—— A company is being formed to erect an electric light plant for both arc and incandescent lighting at Lampasas, Texas. H. E. Hedeman, director.

—— A number of the citizens of Asheville, N. C., are afraid that the electric light tower will some day topple over, and are requesting that stronger guy poles be planted.

—— The New Bedford Gas Company which is running the Westinghouse electric lights in New Bedford, is to introduce electric lights into Fairhaven, across the river, next spring.

—— Mr. Ed. O'Beirne, of the Star Iron Tower Company, is engaged in completing the towers at New Orleans, to which the pole wires of the electric light company are to be transferred.

—— Bids are invited to light the city of Galveston, Texas, for a term of five years from May 3d, 1889. The chairman of the light committee, City Hall, has the matter of bids in charge.

—— The wrangle over the lighting of Vermont street, Buffalo, between the electric light and gas advocates has resulted, as it should in these days of progress, in the selection of the electric light.

—— The Bay State Gas Company, of Boston is reported to have effected a snug little loan of $12,000,000 from a syndicate of London bankers. President J. Edmond Addicks is said to have secured the loan.

—— Revere, Mass., has voted to light the streets of the town by electricity. Another meeting will be held to decide whether to accept the tender of the North Shore Electric Light Company or to build a plant.

—— The Clark Electric Company, New York, has recently issued a neat little pamphlet, calling attention to the Clark system of arc lighting. This system won the medal of "Superiority" at the American Institute Fair of 1888.

—— A contract has been made with the St. Croix Gas Light Company to light Calais, Me., with electricity for twenty months, ending October 1, 1890, at the rate of $72 per light. It is thought about twenty lights will be required.

—— The Sandusky Gas Company, of Sandusky, Ohio, has just purchased one 65 light and three 30 light Brush dynamos, together with 155 double Brush lamps to replace an equal number of lamps of other companies.

Lightning Arresters and the Photographic Study of Self-Induction.

Mr. E. G. Acheson's paper read before the American Institute of Electrical Engineers, at the College of the City of New York, January 8th, 1889.

If in the opinion of any an apology is required—and it is thought that such will be the case—for thus presenting a subject that is in any of its parts a reproduction of the experimental work of such authorities as Professor Hughes, Professor Lodge, Dr. Hertz and others, the excuse is offered that the original motive thought when entering into the series of experiments referred to in this paper was a legitimate one—the clearing away of a little fog surrounding some annoying phenomena attending the working of cables of electric conductors. The investigations became so interesting, so striking and suggestive, and some of the results appeared to have such a value, that it was believed they would afford sufficient excuse for this presentation.

While the measurements made during these investigations were not as accurate as it would be possible to obtain with more refined instruments, the probable errors were not so great as to make them wholly valueless, care in the readings and many determinations checking to a great extent the errors due to the crudeness of the apparatus. Appreciating the fact that untruthful results are less desirable than none, owing to their misleading effects, it is intended to impress the fact that the determinations contained in this paper can at best only serve as a possible check upon future work of a more complete and accurate character. It is also to be hoped that they may promote the already lively interest displayed by the scientific world in discharges, and the sometimes oscillatory character of electric currents.

The mass of material and composite charter of the work to be presented will necessitate considerable care in selecting the order of presentation, and it is believed that the subject can be more easily followed if the thoughts and experiments succeed each other in the order in which they occurred to the experimenter, and this plan will be followed even when the afterthought is of the greater importance.

As previously stated, the primary motive from which followed this series of experiments, was the clearing up of some uncertainty as to the cause of a few annoying troubles in electric cables. But, to be more precise, it was desired to determine the cause of the occasional "grounding" and failure of cables used in telegraphic and telephonic service, when to all outward appearances they were perfect in construction, protected with lightning arresters, and immediately before the moment of grounding indicated high insulation resistances. A case of this kind presented itself for solution, in which there were some features of peculiar attraction to an investigator. It was a cable containing five wires about one mile in length, and of that design known as anti-induction, the cross-section being star-shaped, each conductor having a surrounding wall of lead. It was used for telegraph work, and the conductors were connected at the ends to overhead lines, lightning arresters being provided for the protection of the cable; the terminals of the cable were on poles some 20 feet in height. The ground plates of the arresters were connected to the earth in the usual manner; that is, by wires running down the poles to plates in the ground.

This cable was continually getting into trouble, the conductors becoming solidly "grounded," and upon examination it was found that the "grounds" were caused by little kernels or spots of carbonized insulation. It was at the first moment thought that these had been introduced in the manufacture of the cable, but their repeated formation emphatically declared against this theory and made it imperative to learn the true cause. It was not probable that they were produced by the working currents, for they were of comparatively low electro-motive forces, while the presence of the lightning-arresters would, in accordance with the prescribed rules of their action, render it wholly unlikely that they could have been produced by lightning.

A close study of the experiments of Professor Hughes on self-induction, and of Professor Lodge on the "alternative path" had produced an unsettled condition of my ideas as to the true value of a lightning arrester. The work of these investigators, together with some few experiments of my own, had produced a feeling of interest as to the efficiency of even the best arranged arresters as connected in ordinary practice. I was prepared to believe this to be a practical live case of a well-mounted and connected lightning arrester not protecting. It even seemed possible that the cable itself was, in reality, protecting the protector, when viewed in the light of Professor's Lodge's "alternative path" experiment.

In order to come to some definite and practical conclusions as to the possibility of these troubles having been produced by lightning, a series of experiments was undertaken on lines somewhat analogous to those of Professor Lodge.

In Fig. 1, the general and important conditions of a cable placed on the earth and provided with lightning arresters as usually connected, are outlined. In the figure, K represents the cable, L the line wire, and W the ground wire connecting C to the ground plate G.

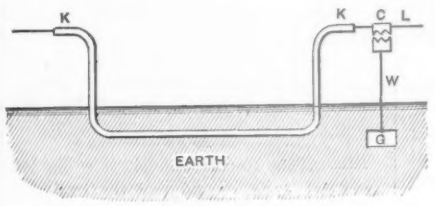


FIG. 1.

It is generally supposed that lightning—or an electrical discharge, as I prefer to call it—produced by the difference of potential between the cloud above the wire L and the earth beneath, would, upon striking the wire, pass to the lightning arrester C, jump across the space separating the points to the wire W and thence to the earth, or the reverse, as the case may be. But while this is probably the case in many instances, it has not yet been satisfactorily demonstrated that there have not also been many cases where this plan of procedure was materially departed from, the discharge making a path for itself through the cable and the insulation, or perhaps dividing itself between both routes. In order to obtain more clearly defined ideas of the action of a discharge under these conditions, the apparatus shown in Fig. 2 was used, in which it will be seen that the fundamental principles and connections of Fig. 1 are reproduced for experimental work, the cloud being represented by the inner coating of the Leyden jar J, and the earth by the outer one, the charge being produced by a Holtz machine, of which M and N are the conductors. The long length

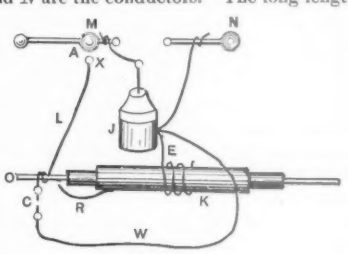


FIG. 2.

of the cable in Fig. 1 is replaced by a short one K. As before, L represents the line wire, and in this case is connected directly to the conductor O in the cable. The lightning-arrester is replaced by an equivalent C composed of two points separated an appropriate distance. The wire W is, as before, the ground wire connecting C in the former case to the earth, and in the latter to its equivalent, the outside of the jar; the lead covering of K is also connected by means of a short wire to the same outer surface. While in Fig. 1 the point on the line L which is struck by lightning is subject more or less to accidental conditions, it is in the case of Fig. 2 selected and adjusted by the ball X, as is also the value of the energy of action, by the areas of the surfaces on the jar J and the length of the striking distance A.

With the apparatus arranged as just described and illustrated, it was quickly determined that a discharge could with great ease be caused to pass through the insulation of the cable, even when the space, C, was but a fraction of the distance through the insulation, and the length of W a few inches of stout copper wire. The current of discharge seemed to divide itself, a portion passing by W producing a spark at C, and another portion passing through the cable. A few more experiments also demonstrated that the wire W had apparently as much influence on the results as the space C, and consequently it became necessary to analyze the combination more completely to determine the relative values of C and W. With this

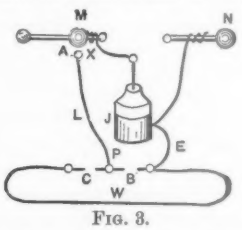


FIG. 3.

object in view, the cable K was thrown out of the combination, and the connections simplified to those shown in Fig 3. On close examination they will be found to be in every way similar to those in Fig. 2, with the exception of the replacing of the insulation of the cable K with a clear air-space B, and instead of connecting L to the conductor O, it is here connected to a post, P. The spaces C and B were both adjustable to a fairly accurate degree, B being easily readable to thousandths of an inch.

The system of experimentation was to take a certain length of wire W, adjust A and C to known values, and then adjust B so that one spark would occur there for about every ten at A, and after having noted the length of the spark B a few inches would be cut off from W and B readjusted and again noted; this being repeated until W was wholly consumed. The value of B to these various lengths of W and a known length of C having been obtained, a wire similar to the original W was substituted for the former, and C having been removed from the circuit, as shown in Fig. 4, a similar set of tests were made, and the difference between the results, with and without C, indicated the true values of C and W in the combination, while the results with W alone show the value of each additional inch.

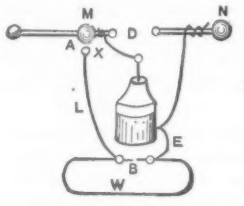


FIG. 4.

In Plate A the results of these measurements have been plotted into curves. The length of W in inches is plotted horizontally while B in thousandths of an inch is laid out vertically. The capacity of the jar J was .0025 M. F., and A was retained uniformly at .286 of an inch. The dull line curve is that of W without C in the circuit, while the dotted one is that obtained with it in. The length of C was .02 of an inch. W for both tests was composed of a copper wire having a diameter of .052 of an inch.

A brief study of these curves teaches that when W is but a few inches in length, C plays a very important part in determining the length of B, and also that its influence rapidly vanishes as W is lengthened, and actually produces an opposite effect after a certain length of W has been arrived at. Thus, with W 20 inches long, C has a value equal to 59 per cent. of the total circuit. At 110 inches it appears to have no value, while at 180 inches the value of the compound circuit is about 7 per cent. less than W alone. These points are, however, of even less importance than the lesson to be learned from the study of the curve of the results obtained with W alone. Here is a case where a relatively small amount of energy contained on the surfaces of the jar J will, when discharged into the circuit composed of the air space A and the wires L, W and E, cause the passage of energy in the form of a spark at the point B of a length of over one-third of an inch, and this when the wire W is but 20 feet in length, or that of an ordinary ground wire down a telegraph pole.

This does not look very encouraging for lightning arresters with long ground connections, and rather puts to ridicule the fine adjustment of the points of these devices. The subject will, however, stand more than a little study and investigation before forming judgment, and perhaps the arrester is all right after all, in so far as the close adjustment is concerned, even if the long ground connection does have to go.

Those who are familiar with the recent investigations of Prof. Lodge, investigations so exceedingly interesting and now so celebrated that few there are who have not made themselves familiar with them, will at once have recognized in Fig. 4 connections very similar to those used in the experiment of the "Alternative Path," by Prof. Lodge. The results obtained by him and in the present experiments are in the main the same, and those differences that do exist are probably to be attributed to the following facts: Prof. Lodge's work was done with instruments of great precision, the sparks were always produced between balls or rounded surfaces, and the object was to determine laws and formulate the mathematics of those laws; while, on the other hand, the experiment now being presented were made in some cases under the most difficult conditions, with apparatus limited to a most exceptional degree both in quality and quantity, a certain portion of the sparks were produced between points, and the object in view was to dissect, analyze and subjugate the phenomena under examination to and for the benefit of practical work, the every day affairs of the electrical profession.

It is, however, exceedingly difficult to avoid a little speculation now and then, as the subject unfolds itself, and it is hoped the experimenter may be pardoned for any references that may be made to the theories that have been the immediate cause of some of his researches. It is even hoped that the work performed may atone for the views about to be advanced, notwithstanding the fact that they are quite contrary to those deduced by so high an authority as Professor Lodge.

After a considerable portion of this work had been done and the conclusions more or less formulated, I was much pleased and greatly strengthened in the opinions then being formed to learn through a letter from Professor Hughes to Professor Lodge, published in the London *Electrician*, issue of Sept. 28, 1888, that Professor Hughes had, at least formerly, held the same view of the "alternative path" that I had formed, and which will now be presented in connection with what is thought to be experimental demonstration of their truthfulness.

Referring to Fig. 4, it will be seen, as has already been stated, the conditions and arrangements of W and B are such as to produce and actually constitute the "alternative path," as shown by Professor Lodge. The simple assertion that they are alternative paths does not, however, make them such, and, while they may under certain conditions and adjustments become so, it is possible to conceive of their being otherwise. Is it not within the bounds of reason to assume that the energy that has been discharged from J traverses the wire W, and in so doing so produces a condition that may be termed *electrification*, and on the disappearance of the controlling influence of this energy, would not the wire W return with an almost infinite rapidity to its original non-electrified condition, and in doing so, produce as the result of this enormous rapidity of motion, an electro-motive force at its terminals of a greater value than that of the original energy? In other words, will there not be a restoration of the energy expended in distorting the lines of energy within the wire, and this restoration being performed in a shorter interval of time than that occupied in its production, a higher electro-motive force would be obtained even though the value of the returned would be less than that of the original, to the extent equal to the losses due to the internal friction of the mass.

This being the case, this current of discharge from the wire, and which was first discovered by Henry and investigated by Faraday and called by him the *extra current*, would, owing to its greater electro-motive force, jump the space B and thus close its circuit, even when the distance was such as to prohibit the passage of the original current as discharged from the jar J.

It seems as though this might be the case, and, if it is, then the discharge that was obtained through the insulation of the cable in Fig. 2 need not have been a part of the original current from the jar J, but the current discharged from the wire W. If it was, a shortening of W would tend towards overcoming the difficulty. To test the case a short wire R was attached to the lead and bent over the insulation so as to present a point to the conductor O, the distance between the point and the conductor being about the same as the thickness of the insulation; W was now removed, as was also C. It will be seen that E, the lead of the cable K, the short wire R and the space separating its end from the conductor O, form an equivalent to W and C. With this arrangement it was not possible to cause a discharge to pass through the insulation.

Now, in accordance with the views which have seemed to me most probably true, this change is due to the reducing of the length of the path W, and which is now composed of R E and the lead of the cable, this reduction resulting in a subsequent lowering of the potential of the extra or self-induced current. But if the theory of Prof. Lodge's "alternative path" is correct, then the change would be due to a removal from the path W of a certain amount of resistance, which has been termed by Mr. Oliver Heaviside, *Impedence*.

We here have an apt illustration of inertia under the American and English definitions, as so forcibly stated by Prof. Ayrton. As I have presented it, the spark B is the result of inertia, with the American definition—a resistance to stopping; while Prof. Lodge's theory would account for it by inertia with the English interpretation of that word—a resistance to motion.

Accepting the belief that the spark B, when adjusted to the critical point, was caused by the self-induction to the wire W, a variety of experiments were made with the desire of obtaining experimental proof of the theory. Repeated opportunities presented themselves for mathematical work, and if time and attention could have been given in that direction, the results would unquestionably have been of interest and value, but the work was perforce restricted to the more limited confines of experiment and reasoning. The first experiment of the series was to replace the wire W in Fig. 4, with one of smaller diameter and re-determine the value B in a manner already done for a copper wire having a diameter of .052 of an inch, and of which the results have been plotted in Plate A.

Before presenting the experimental results, it is desirable to consider what might be expected from these changed conditions. There will in all cases be practically the same amount of energy discharged into the circuit, for the areas of the condensing surfaces on the jar J remain constant, the length of the striking distance A also remains of a uniform length, and while it is true that the resistance of W, as measured

by a Wheatstone bridge, would vary inversely as the square of the diameter, the resistance of the complete circuit of discharge is, owing to the air-space *A*, practically infinite, and hence the relative trifling resistance of *W*, even when of the finest wire, may be wholly neglected.

The theory that the self-induced or extra current in a wire is a recoil action, is based primarily upon the hypothesis that there exists, before the electrifying current is discharged into the circuit, a prior state—the *electro-tonic* state of Faraday. This *electro-tonic* condition consists in the existence of lines of energy—thermal they may be—with directions coinciding with the radii of the wire; these lines or axis of energy being surrounded by circular lines of magnetic force. An electrical current being discharged through such a wire would cause, under the influence of its well known magnetic whirls or circles whose planes are at right angles to the line of propagation and in this case to the axis of the wire, a deflection of the planes bounded by the closed lines of magnetic force surrounding the radial lines of energy which are within the wire. The work of producing this deflection would, I think, constitute what is known as the variable resistance which meets a sudden discharge and which was made the subject of that grand paper on "Self-Induction," by Prof. Hughes before the Society of Telegraph Engineers, at their meeting of Jan. 28, 1886. This deflecting of the radial lines of energy, while constituting a resistance to the inducing current is also the source of, or rather, during the act of deflecting, produces an electro motive force contrary to that of the inducing current. This counter electro-motive force exists only during the interval of deflection, and quickly vanishes from the path of the inducing current. On the moment of the interruption of the inducing current, and consequent withdrawal of its attending magnetic whirls or circles, the deflected radial lines of energy swing back to their radial positions, producing by their motion an electro-motive force of such a direction as to form a current in the same direction as that of the inducing current. This return swing or recoil, as of a spring suddenly released, is of such velocity, and overlapping, probably, what may be likened to the tail end of the disappearing inducing current, produces a momentary electro-motive force of a value higher than that of the original current. These being the actions of the forces and energies, it now becomes necessary to understand what differences, if any, the size the wire through which the original current is discharged will have upon the value of the induced, or as it is more generally termed, the self-induced electro-motive force. All of the experiments and considerations will be made under the conditions of a constant capacity for the jar *J* and uniform length of *A*, and consequently one value for the energy discharged into the circuit. In all cases there will, of course, be a certain amount of the energy that has been discharged into the wire lost and converted into heat. This lost energy will be greater in value in the smaller wire than in the larger in a proportion inversely as their diameters. This greater loss in the small wire and resulting reduction in the available inducing energy would, of course, tend to produce a diminution of the self-induced current. This reduction is, however, exactly offset by the greater concentration of the inducing energy, its inducing value having been increased in a proportion inversely as the diameters of the wire.

It is feared this argument has become tiresome, and an immediate relief will be found in Plate B, where I have plotted two curves; one, the full line curve, is the same as that shown in Plate *A*, and was produced as formerly stated. The dotted line curve was made with a wire of copper having a diameter of .032 of an inch. The two curves are so nearly alike as to permit of the belief that they are in reality the same and that the slight differences existing are due to errors of measurement. Here is experimental proof that the electro-motive force of the self-induced current, as measured by the spark *B*, remains constant as long as the energy discharged into the circuit is of uniform value, and is wholly independent of the diameter of the wire, and this seems to give countenance to the argument immediately preceding.

It is more than probable that those who have been following the subject closely will, before this time, have had the question asked, from somewhere within: "How would these curves on Plate *B* have looked had one been made with an iron wire?" The answer is ready at hand on Plate *C*. It is not exactly an answer to the question as stated, for there are here shown two curves, one produced with an iron wire and the other with a copper wire, but both are of the same diameter, .052 of an inch; the curve of the copper wire is the one you are already familiar with.

This paper has even now attained to such proportions, and there are yet so many points to present, that nothing more than a moment's glance at these curves can be offered. A study of them teached that for lengths of 40 inches, copper and iron will, when acted upon inductively by discharges of one value furnish self-induced currents of like electro-motive forces. From 40 to 110 inches they show slightly different values, while beyond this length their efficiencies rapidly diverge; that of the iron running much lower than that of the copper, and apparently fast approaching a maximum. As a means for accounting for these different efficiencies, I would suggest this theory. Up to 40 inches of length the time occupied by the passage of the discharged current was too short to permit of any magnetic effects occurring in the iron, and consequently the wire was equivalent to its neighbor, the copper; from 40 to

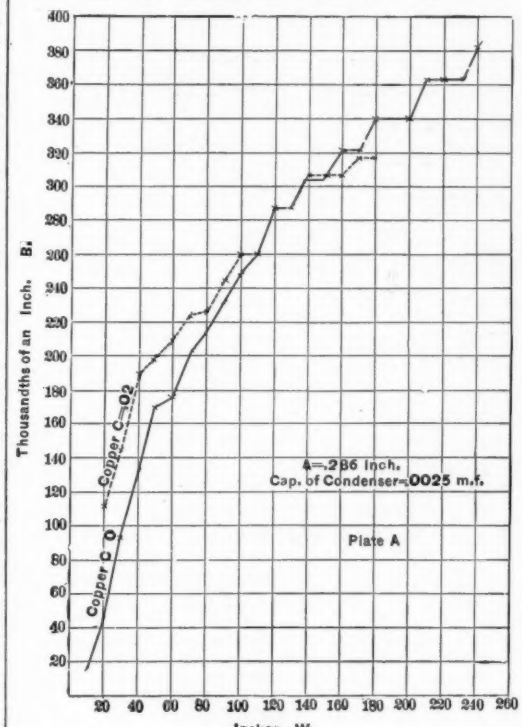


PLATE A.

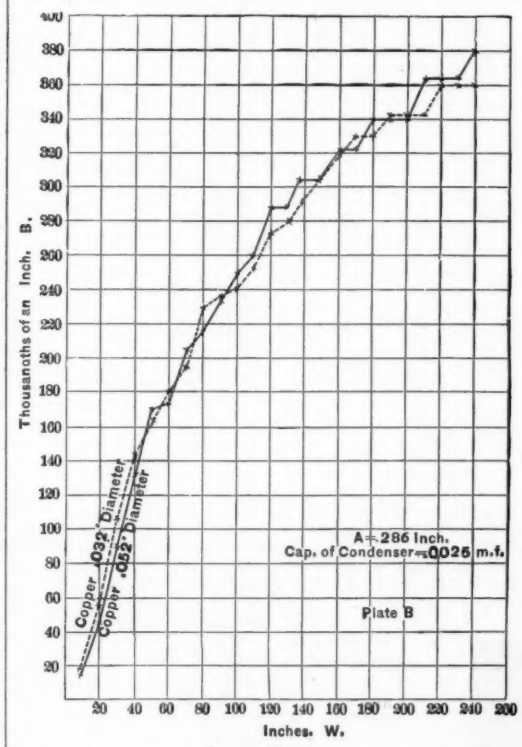


PLATE B.

110 inches small magnetic effects were produced, resulting in a lag or retardation of the velocity of the recoil deflection of the radial lines of energy, and resulting, of course, in a lowering of the electro-motive force of the self-induced current; beyond 110 inches, the time of discharge rapidly increased in duration, and thereby produced the decided flattening of the curve, as shown.

There is one more set of curves to present: They are shown in Plate D, and were made with the object in view of determining the effect of a variation in the amount of energy discharged into the circuit. Experiments were made with both copper and iron wires, the curve of the copper plotting in above that of the iron one. In the plate, the capacities of *J* in millionths of a microfarad are plotted horizontally, while the lengths of the *B* sparks in thousandths of an inch are plotted vertically. The length of the *A* spark was, as before, .286 of an inch. I was prepared to see the *B* spark increase as the energy discharged increased; but I was wholly unprepared to have it decrease as the result of added energy, after a certain point had been arrived at, and still less prepared to obtain the wavy curves, as shown.

Time will not permit of entering into any consideration of the peculiarities of these curves.

There is a little experiment, the record of which I wish to interline at this point; it may answer a question, and perchance wet the powder of some intending questioner. Looking over my sketches and coming to Fig. 3, the thought struck me that an error might have been introduced into the experiment where the *C* spark formed a part of Prof. Lodge's "alternative path," due to there being no connection having other than an infinite resistance between the ball *X* and the outer coating of *J*, while in all of the other experiments there was the circuit formed by *W*. It seemed possible that this change might have produced a different value for the energy of the discharged current, as the difference of potential between *M* and *X* might be altered. To decide the question, the connection as shown in Fig. 4 were used. The balls forming the terminals of the Holtz machine were caused to approach each other until the discharges occurred about an equal number of times between them at *D* and *A*. Next the space *B* was adjusted to the critical length. If the existence or non-existing of the wire *W* and resulting metallic connection between *X* and *J* influenced the value of the potential of discharge, its removal ought to lower the potential difference between *M* and *X* and cause all of the discharges to occur at *D*. The experiment, however, did not prove this to be true, the removal or replacement of *W* having no apparent effect upon the number of the discharges that occurred at *A* and *D*; but, of course, when it was removed every spark at *A* caused one at *B*.

A few experiments were now made to determine the effect various portions and positions of the parts of the wire *W* would have upon other portions of itself. The connections shown in Fig. 4 were used. A length of 50 inches of cotton-covered copper wire, with a diameter of .033 of an inch, was used for the wire *W*. It was arranged in the form of a circle. *A* was, as before, .286 of an inch, and the capacity of *J* was .0025 M. F. The critical point of *B* was found for these conditions, and *W* was then formed into a figure whose two sides were parallel, and *B* was measured for various distances between the two sides. These distances were, however, only approximate.

Position of *W*.	*B* in inches.
Circle	.182
Sides separated 3¼ inches	.170
Sides separated 2½ inches	.137
Sides separated 2 inches	.137
Sides separated 1½ inches	.137
Sides separated 1 inch	.137
Sides separated ½ inch	.114
Sides separated ⅛ inch	.050

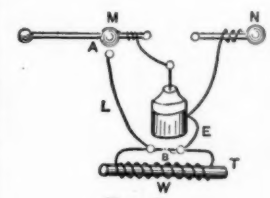


FIG. 5.

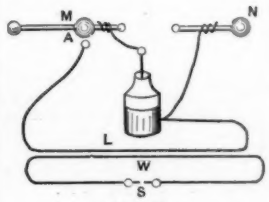


FIG. 6.

The next experiment, illustrated in Fig. 5, was to take the same wire *W* and coil it upon a paper tube having a diameter of ¼ of an inch, the wire forming a spiral of any layer about two inches in length. This spiral being placed in the position *W* the critical point of *B* was found to be .197 of an inch, or over eight per cent. greater than when the wire was in a circle. While the spiral was in the last position, an iron wire one-tenth of an inch in diameter was inserted into the paper tube, and now the spark *B* only measured .170 of an inch, over 13 per cent. less than without the iron wire, and more than six per cent. less than the plain circle. Another experiment was made like the last, with the exception that the wire was long, and bent around into a closed circuit, but it did not alter the results. The lowering of the value of the self-induced current upon the introduction of the iron wire was to me at the time startling, but a consideration of the case showed that it should be so, for a portion of the energy of the inducing current was absorbed in producing work in this mass of iron, and of a necessity weakened the self-induced current to an extent measured by the work this extracted energy could and would have done in the wire *W* had it not been withdrawn. I have, however, here a confession to make; I was all of the time considering that this energy was expended in producing magnetic effects in the iron wire until a friend who had called to see some of the experiments suggested that I insert a copper wire instead of the iron one. I did so. The effect was the same as that obtained with the iron wire. The explanation was simple: It was that not magnetic effects, but electric currents, closed upon themselves within the wire had been produced. The reduction of the length of the spark *B* now became a simple question of causing the inducing current to do more or less work external to the wire *W*, and as another means of causing it to do so, the spiral was surrounded by another spiral of wire with the ends so arranged that they could be connected or opened as wished. With this arrangment, the spark *B* could be made to come and go, as desired; for by adjusting it to the critical point with the terminals of the outer spiral open, it would entirely disappear when they were united, all of which agrees perfectly with the former experiments and conclusions.

Another short series of experiments was conducted with parallel circuits, as shown in Fig. 6. The lengths of the parallel portions were 35 inches, the distance separating them being .052 of an inch. The total lengths of *L* and *W* were 130 inches. *A* and *J* were of the same values as heretofore used.

The conditions of the tests and the resulting lengths of the spark *S* may be briefly stated thus:

Test No. 1	*L* was copper, diam. .052 in. *W* " " " "	S=.031 in.
Test No. 2	*L* " " " " *W* " iron " "	S=.024 in.
Test No. 3	*L* " " " " *W* " " " "	S=.030 in.
Test No. 4	*L* " " " " *W* " copper, " "	S=.025 in.

If my memory serves me right these results are the same, qualitatively, as those obtained by Professor Hughes, and clearly show the apparent sluggish action of iron, both in imparting and receiving magnetic inductive effects. Its relations to these magnetic effects resemble the actions of a polished metal surface when associated with heat, it radiates and absorbs poorly.

It now becomes my pleasant duty to present the concluding and, at the same time, most interesting and convincing proofs that *W* is not an "alternative path," but that the spark *B* is produced by, and consists of, the discharge of the self-induced current. I have called this series of experiments

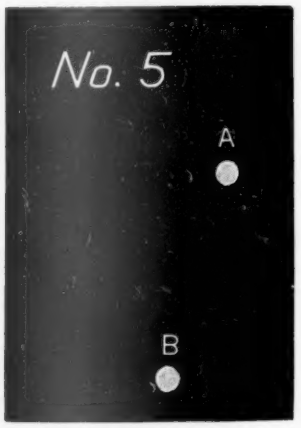
THE PHOTOGRAPHIC STUDY OF SELF-INDUCTION.

Unfortunately, at a late day, a day so late as to prevent my repairing the loss, I met with at least two accidents, and each of them cost me one or more negatives which were a part of the record of these experiments. I shall, however, endeavor to make those remaining demonstrate the desired points.

In making these experiments the end in view was to obtain photographic records of the duration of the spark *A*, with and without the spark *B*; with and without the wire *W*; with various lengths of the wire *W*, and, if possible, to detect a difference in time between *A* and *B*. A disc of tin plate, 20 inches in diameter, was mounted on an arbor and belted to a system of pulleys of such sizes, that by working the train by hand, a velocity of about 75,000 inches per minute could be given to a circle of holes that had been punched in the disc at a distance of one inch from its edge. These holes were about one-eighth of an inch in diameter and one inch apart, from center to center. The disc was so placed, in relation to the positions of the *A* and *B* sparks, that a line stretched from *A* to one of the holes in the upper edge of the disc, would pass through *B*. Immediately back of this same hole a sensitive plate was fixed so that the hole was in front of the center line, while the plate was removed sufficiently far to avoid being touched by the disc.

One-half of the sensitive plate projected above the edge of the disc; this upper portion was covered with a tin plate in which a hole was punched of a size similar to those in the disc. The lower portion of the sensitive plate—that is the part back of the disc—was also covered with a tin plate in which a window had been cut a little over one inch square, and in such a position that the holes in the disc passed in front of it. It will be understood from this description, that while the disc revolved there could be two holes in front of the window, while there could not be less than one. With these adjustments sparks at *A* and *B*, separately or united, would produce an impression upon the sensitive plate, through the upper hole, and through one or two holes, as the case might be, in the revolving disk.

As a result of the accidents above referred to, it will be necessary to introduce the series of experiments with photograph No. 5, where we have the spot produced through the hole in the upper stationary screen marked *A*, and a spot lower down on the plate marked *B*, and which was produced through one of the holes in the revolving disc. The object in having the spot



A was that it might offer a means of comparision between impressions made through stationary and moving apertures, and also show the effect of vibrations, if any existed, in the various parts of the apparatus. The value of the energy discharged through the circuit from *J* was disregarded, care, however, being taken that there should be no change in it throughout the entire series of experiments. The velocity of the apertures or holes in the disc, was fairly but not absolutely, determined to be 75,000 inches per minute. With this velocity of movement, a displacement of the apertures of the one thousandth part of an inch would represent an interval of time equal to $\frac{1}{75000000}$ of a minute.

The series of experiments will be divided into four sets, as follows:

Experiment 1, Photo. No. 5.

The wire *W* was of copper, 76 feet long and .052 of an inch in diameter; the spark *A* was $\frac{5}{16}$ of an inch, and was retained at this for the entire series.

The *B* spark was adjusted to a point near the critical state, but, owing to the necessity of its production with the first *A* spark, it could not be set to the same delicacy of action as heretofore. The photograph shows a slightly blurred or indistinct outline on the right-hand side of the spot *B*, which is more

clearly brought out by comparison with the spot *A*. From this it is concluded that a measurable length of time was occupied by the spark, as the aperture in the disc through which this *B* spot was produced must have moved an appreciable distance in order to have produced this elongation or "ghost," as the photographic profession would term it. Owing, however, to the absence of any displacement of the distinct outlines of the spot, it cannot be assumed that there was any difference in the time of *A* and *B*, or at least, not of sufficient value to permit of measurement with this apparatus.

Photograph No. 6.

In producing this photograph all of the conditions remained the same as those in photograph No. 5, with the one exception of the spark *B*, which was removed from the circuit by separating the points beyond the striking distance. Here, by chance, two holes, or rather, one and a half, were in front of the window at the moment of sparking and produced spots one and two. These spots exhibit displacements that, roughly measured on the negative, are one-tenth of an inch in length, and show a duration of the spark of not less than $\frac{1}{750000}$ of a minute.

From these two photographs the conclusion is drawn that the spark *B* shortens the duration of the spark at *A*.

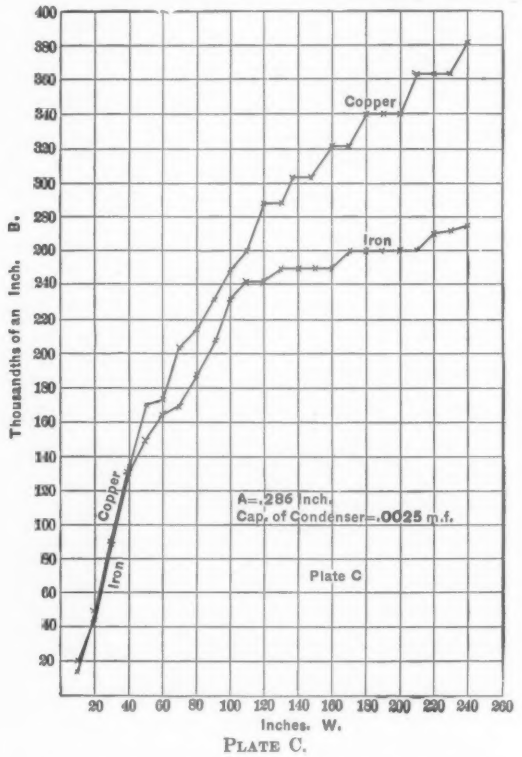


PLATE C.

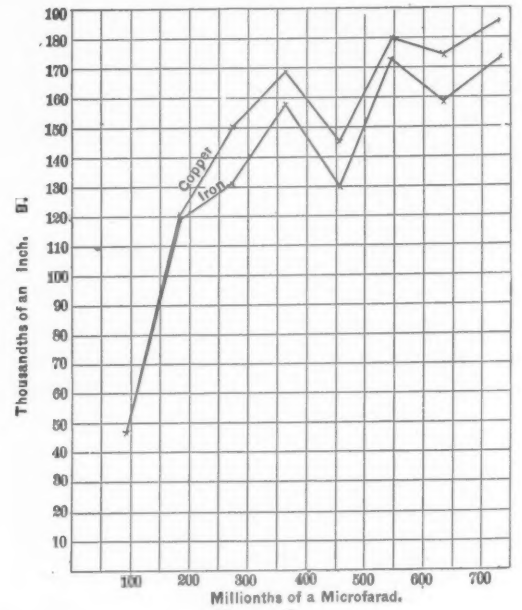


PLATE D.

Exp. No. 2, Photo. 7. The conditions of the circuit in this case were: Wire *W* shortened to 20 inches in length; spark *B* still out of circuit. This photograph shows about the same length, but darker "ghost" following the spot *B* than did Photo. No. 6, and indicates a corresponding increase in the *work done at A*.

The conditions are the same as the last, excepting that the *B* spark is again introduced. While there is still a measurable duration to the spark, the shortening of the interval due to the spark *B* is very decided.

Experiment No. 3, Photograph No. 9.—In this experiment the entire apparatus associated with the spark *B* was cut out and the outer surface of the jar *J* was connected by a short copper wire to the ball *X* (refer to Fig. 4). An examination of the photograph indicates that *A* existed for an interval of time approximately equal to that of the last experiment (photograph No. 8) and very much less than that shown in photographs Nos. 6 and 7.

Photograph No. 10.—In this case the wire *W* was removed and the spark *B* adjusted to about $\frac{5}{16}$ of an inch. There seems to be, possibly, a very slight increase in the time over that of photograph No. 9.

Experiment No. 4, Photograph No. 13.—To this photograph special attention is invited. The conditions under which the negative was produced were wholly different from the foregoing. The tin plate covering the upper half of the sensitive plate, and which carried the aperture through which the spots *A* were made, was removed, the plate was lowered, so that a point represented by the spot marked *I* came on a line with the apertures in the disc. The wire *W* was composed of 50 inches of cotton covered wire like that used in some of the earlier experiments, and was formed into a circle. The *B* spark was removed and was not used during this set of experiments. The *A* spark was, as before, $\frac{5}{16}$ of an inch, and the spot *I* in the photograph is its impression through an aperture of the disc, and, as readily seen, shows a very considerable duration of time.

The sensitive plate was now elevated a little, the wire *W* was coiled into a spiral, as described in a former experiment, and the spark *A* was once more caused to pass. Spots 2 and 2′ are the impressions produced by it, and as will be seen by close inspection exhibit longer "ghosts," and consequently a greater interval of time than was shown in spot 1. Once more the sensitive plate was moved upwards, and an iron core having been inserted into the paper tube upon which *W* was coiled, the spot 3 was produced by another spark, the "ghost" produced being smaller than either of the former ones. These three experiments show conclusively that the presence of the wire *W* in the form of a loop or circle in the path of the discharged energy, tends to prolong the action upon the sensitive plate; next, that the coiling of the wire into a spiral, increased the duration of that action, and lastly, that the introduction of the metallic core, and consequent stealing away of a portion of the discharged energy, shortened the time of action to an interval less than that of the loop.

The field opened up by these photographs for theorizing and speculating is a very broad and rich one, but the time is now too

short to more than indicate the manner in which these results add strength to the conclusions deducted from the former experiments. Applying to the photographic experiments the theory already advanced, that the *B* spark was a discharge from the wire *W*, it is found, as would be expected, that when *B* is absent the self-induced current discharges into the jar *J*, producing in its passage a spark at *A*; this spark following immediately upon the heels of the original *A* spark. The jar being in this manner recharged, but, of course in the opposite direction and of a slightly lower potential, will again discharge into the circuit—the discharge at a reduced potential being facilitated by the thermal, and, possibly, magnetic conditions of the air-space *A*, and which were produced by the first spark.

This second discharge will leave the jar *J* once more charged, and will be followed by other discharges of a continually decreasing value, until the energy has been dissipated as heat or other forms of energy through and by the various portions of the circuit. This subject of the oscillating discharge has lately received, at the hands of Dr. Hertz, a masterly and most highly interesting treatment.

Referring once more to photograph No. 6, which was produced by an *A* spark with *W*, composed of a copper wire 76 feet in length, the impression produced by the original, or first spark, is clearly defined, while in its wake is traced the track left by the sparks produced by the rapidly weakening, oscillating, self-induced currents—a track fading away like the tail of a comet, to an invisible end.

The next step in the inquiry is to determine the effect of introducing the spark *B*, and for this purpose reference will be made to photograph No. 5. Here we find, as would be expected, that the comet-like tail has almost disappeared, the natural result of having offered the self-induced currents from the wire *W* a means of short-circuiting themselves across the points at *B*. The slight trace of a tail—a blurred outline—is to be attributed to the self-induced currents of the portions of the discharge circuit lying between the points of *B* and the surfaces of the jar *J*.

Shortening the wire *W*, with the spark *B*

removed, should have the effect of increasing the amount of energy dissipated in the air space *A*, and further than this there should be little or no alteration. This increased amount of dissipation at *A* may be popularly explained thus: The total circuit into which the energy contained in *J* is discharged, and which consists of the space *A*, the wire *W* and the connecting wires, constitute the bodies or spaces from which the energy is radiated or dissipated, and, therefore, any contraction due to removing a portion of them will, of necessity, throw more work upon the parts remaining. That this is correct is illustrated by photographs No. 6 and No. 7, where the conditions were the same, other than a shortening of *W* from 76 inches in No. 6 to 20 inches in No. 7. A comparison shows that while the length of the "ghosts" are practically the same, that of No. 7 is heavier, more material. In the same manner in which the work was increased in the space *A*, so will it be increased in the wire connecting the points at *B* to the surface of the jar *J*, and for this reason the introduction of the spark *B* should not be

expected to cut off the tail from the spot *B* to the same value obtained with a long wire at *W*. This is the case, as is shown in photograph No. 8, where *W* is 20 inches and *B* has been returned to the circuit. If the "ghost" shown in photograph No. 8 was due to the self-induced currents in the connecting wire, as has been assumed, then the same results should be obtained by cutting off the entire portion of the circuit represented by *W* and the apparatus associated with the *B* points, and short-circuiting these connecting wires. That this is the case is shown in photograph No. 9.

Cutting out *W* and replacing *B* did not seem to alter the results very much, if any, from those last mentioned, and this is just what would be expected.

In photograph No. 13 it is demonstrated that the coiling of a wire into a spiral tends to cause a retention of the energy within itself, and is due probably to the gathering up of a portion of the energy radiated or dissipated by one convolution by the adjoining convolution, and thereby restoring it to its own mass. This retarding of the process of dissipation will result in a prolongation of the time of *A* and consequent action on the sensitive plate, as is shown by the increased length of the "ghost," following spots 2 and 2′ over that following the spot *I*. As would be expected, the length of the "ghost" is immediately contracted upon increasing the rate of dissipation of the energy as results from the introduction of a metallic core in the coil of *W*, as is illustrated in Spot 3.

FINAL CONCLUSIONS.

The final conclusions to be drawn from these experiments are:

1st. The "ground plate" of a lighting

arrester should be connected to the earth by as short a connection as may be possible.

2d. When an air line connects to a cable, a lightning-arrester should be provided and attached to the armor of a cable by a connection not more than a few inches in length.

3d. When a short "ground wire" cannot be used, one formed of a number of strands may be used, and preferably not twisted into a cable.

4th. Any method by which a portion of the discharged current which passes over the "ground wire" may be withdrawn, will tend to increase the efficiency of the arrester.

5th. Under conditions similar to the tests, copper or iron may be used with equal efficiency, when the lengths are under 40 inches, and over this length iron is more efficient than copper.

6th. The resistance of the "ground wire" is of little consequence, but it should have a size sufficient to carry off the charge without overheating.

7th. The insulation in a cable may be punctured by lightning, either by the direct discharge, due to the points of the arrester being two far apart, or by the current of self-induction from the "ground wire," when that wire is of any considerable length.

8th. Dissipation of the energy of discharge reduces the self-induced current.

The Lighting of Chicago by Electricity.

The Chicago plant of arc lights is a general theme of conversation, and a rivalry has sprung up in the city council, as to who shall be the champion of electric lighting. Alderman Clarke was the most enthusiastic on that score at the time of his decease, and there is now a friendly rivalry between Aldermen Whelan and Dixon, for the mantle of the late alderman. Both gentlemen are for lighting the entire first ward by electricity. Dixon is on the Finance committee, and is after an appropriation of $100,000, to extend the present plant, while Whelan, who is on the gas committee, wants the gas appropriation scaled down to furnish the funds. He says he wants $150,000, one-half for the first ward, and the other half to go to the 24th and 18th wards. For a few evenings after the lighting of the streets by the new lamps, the gas lamps were permitted to burn, but these are now excused from further service as illuminants. The average of five gas burners will be displaced by each arc lamp. This will throw out of service about 1,000 gas burners.

Now, the cost of the 180 lamps just added to the plant—what was the river plant—is about $51,000, or about $280 per lamp. The cost of gas lamps per annum to the city is $26 each. Then 1,000 lamps displaced is $26,000. The maintenance of the plant will be not far from $15,000 per annum. Interest at four per cent. on $51,000—money can be borrowed by the corporation at that rate—is $2,040, which, added to cost of maintenance, foots up $17,040, as against $26,000 for gas. These are the kind of figures which make the electric light preferable from a commercial standpoint. Prof. Barrett has plotted a map of districts where he will make the next illumination, if permitted, and has embodied with this a report to the Commissioner of Public Works, and it is believed that $150,000 to $250,000 will be appropriated for this purpose. An appropriation of $150,000 can be made up as follows:

Savings on gas appropriation	$75,000
Tax on telephones, at three per cent	30,000
Drug store liquor licenses	20,000
Unexpended oil and gas appropriations on hand	25,000
	$150,000

Southern Electrical Notes.

Mr. Chandler, agent of the Gamewell Fire Alarm System, of New York, has just returned home from a visit to Mobile, Ala., where he went to inspect the new system of his company, just put in operation for that city. He reports the work well done, and the system working successfully.

The telegraph line between Plant City and Bartow, Fla., has been completed.

W. C. Harris, of the Southern Electric Company, of Birmingham, is in Anniston, Ala., putting an electric apparatus in the new Wilmer hotel. He also represents the Gaznor electric fire alarm, of Louisville, and will put its merits before the city council, for adoption, at their next meeting.

Mr. Belknap, of the Thomson-Houston Electric Light Company, has been in Charlotte, N. C., for several days, negotiating a sale of the Charlotte Electric Light Plant. The purchasers are Dr. R. J. Brevard, Mr. W. C. Maxwell and Mr. J. T. Robinson.

At Macon, Ga., a firm of undertakers have sued the Western Union Telegraph Company, for a delayed telegram, which caused them to lose the sale of a handsome casket. At 11 o'clock on the 18th inst., the firm received a telegram from Eastman, Ga., ordering a certain size casket; at 12.30 the firm telegraphed that the casket would be sent. At 3 o'clock, they received a telegram saying as no answer had been received, the order was countermanded, and the party supplied elsewhere. The firm, therefore, filed suit against the Telegraph Company. The delay was at the Eastman, Ga., office.

Judge Shepherd, who was recently promoted from a place on the Superior Court bench in North Carolina to an associate justiceship in the Supreme Court of the same state, and Hon. Geo. H. Brown, who was appointed by Governor Scales to fill the vacancy occasioned by the promotion of Judge Shepherd—both began their lives as telegraph operators. Judge Brown was at one time chief of the operating force in the Western Union office, in New York City, and many of his old friends there will be pleased to learn of his deserved promotion. Another coincidence is, that they are from the same town and are brothers-in-law.

Conduits for Electric Light Lines.

The Washington and Virginia Conduit Company, a new corporation, of which Captain R. W. Tyler is president, made a proposition to furnish street lights for Washington for about two-thirds the price then paid, and had made arrangements with the Westinghouse Company to build conduits and erect plants as soon as a permit was obtained when, just before the adjournment of Congress, a clause was inserted in the appropriation bill which prevented the execution of a contract for street lighting with any one, except the United States Company, during this fiscal year. The permit to the new company to lay underground wires has been refused by the commissioners, on the report of Capt. Symons, who sees "engineering objections to the duplication of electrical conduits in the streets," and expresses the opinion that, in streets in which electricity is to be largely used, there should be a conduit sufficient in capacity to enclose all lighting wires that would ever be required, with the suggestion that "such a conduit might be built by the general government, the District government, or a private corporation, and proper rental charged for its use." There appears to be a radical difference of opinion on the conduit question between Capt. Symons and Major Raymond. Whatever may be done by the general government or private corporations in the way of building conduits to rent to private parties, it does not seem likely that the District government will go into the business. The meaning of such a scheme would be that the taxpayers of the District would have to furnish capital for the commissioners to invest in constructing a conduit sufficient for the needs of all time to come, without having the right of an ordinary corporation stockholder to express an opinion as to how the money should be expended. Capt. Taylor's company has the services of an able attorney, Mr. H. O. Claughton, and a fight will be made for the right to lay wires, and an opportunity to bid on lighting contracts.

—— The Danvers, Mass., electric lights were run for the first time on Tuesday last, and electric illumination is voted a brilliant success. The Brush system has been installed, 71 lights of 1,200 candle-power each being used. The formal opening of the station occurred on Wednesday last.

—— The Knights Electro, of New Orleans, are to "appear on the evening of February 28th, in an electric pageant of unsurpassed splendor and ingenuity. They will present an ingeniously wittily devised travesty of a local theme, in which the electrical equipment will play an important part."

—— A Pennsylvania hen raiser is down on the electric light. His name is Joe. Hitchner, and he threatens to sue the electric light company. He says the street lights illuminate his chickery so that the hens loaf around all night, refusing to roost, and consequently are good for nothing next day. A man might as well keep a flock of roosters as anything else, under such circumstances, and then to call them roosters would be a misnomer.

Electrically Welded Bale Ties.

The Thomson Electric Welding Company has perfected a machine for welding cut bale ties. By its mean cut ties can be easily united, and the pieces that accumulate at the compresses, which are so well known in the South, can be very quickly made up into proper lengths for use. At the present time the cut band ties, though in large quantities, are worthless except as scrap iron.

Los Angeles Lighted from Towers.

This city is lighted by a tower system. These towers are 150 feet high and are made of two sticks of Oregon fir, tapering from 20 inches in diameter at the base to six inches at the top. There are 24 of these towers scattered over an area six miles square, and carrying 97 2,000 c. p. lights. There are also 25 low lamps at various points in the city. There lights are on two circuits, the longest of which consists of 42 miles of No. 4 wire. The commercial lights number 350, so the total outfit of the station is about 475 lights.

Fire Alarm System for the Navy Yard.

The Washington Navy Yard is preparing to have put up a fire alarm system according to plans and specifications drawn by Commander Bradford. There are to be eight signal boxes, connected with a central station, arranged to automatically strike the alarms on one large bell, nine 15 inch gongs, and twelve 8 inch bells. There is also to be installed a six station watchman's time detector system of the battery-circuit type. Bidders on Bradford's specifications will find none of the ambiguous "workmanlike manner" clauses in them—every detail is laid down with exactness and clearness—and contractors will have to carry them out.

Electricity in Christmas Effects.

On Christmas eve in Trinity church, Boston, a very pretty effect was produced by the use of two three candle power electric lamps placed in a large tinsel star. The current was supplied by a "C. & C." battery. In the Knights of Honor Hall, on Christmas eve, was a large Christmas tree, handsomely decorated. It was placed on a platform which was also loaded with presents. The arrangement was such that the tree was free to revolve in one direction while the platform moved in the other. Power was furnished by a one-eighth horse power "C. & C." motor, which accomplished its work most satisfactorily. Messrs. Howard & Stone, the New England "C. & C." agents, have just sent a small motor to Brockton, where it is running a rotary pump delivering 150 gallons an hour.

Manufacturing Notes.

The Jarvis Engineering Company, of Boston, is to be congratulated on the fine taste displayed in its calendar for 1889. The beautiful engraving is not spoiled by being covered with advertising matter, but is shown in all its attractiveness, a few modest lines at one side presenting the compliments of the Jarvis Company.

The Okonite Company, New York, find the demand for their goods steadily increasing. They have recently appointed the California Electrical Works, San Francisco, Cal., as their Pacific Coast agents. This company is composed of hard workers, well known throughout the West, and are doing a big business in okonite specialties.

Messrs. J. H. Bunnell & Co., New York, are just now engaged in the kindly work of making the printers of the country happy. Bathrick Patent Electric Dissipiator is the name of the little attachment that they handle and which the printer find so efficient in overcoming all trouble from electricity in all kinds of weather, and with all kinds of paper. A number of large concerns endorse the practical working of the Dissipator.

A suit has been commenced in the District Equity Court by the Consolidated Electric Light Company against the administrator of William E. Sawyer, asking an injunction to restrain the issue of patents for certain inventions of Sawyer and an order for the assignment of an interest therein which, it is alleged, is claimed by James Flannigan and James G. Smith, of New York. The applications for the patents in question have been filed by Sawyer's administrator simply to protect the inventions against two years' public use, and without any reference to the question of rightful ownership in case the patents are granted.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING JANUARY 2, 1888.

395,682 Electric train brake apparatus; Augustin I. Ambler, Washington, D. C., assignor to Roselin N. Ambler, same place.
395,703 Trolley for electric railways; Wilton F. Jenkins, Richmond, Va.
395,706 Dry voltaic battery; Isidor Kitsee, Cincinnati, Ohio.
395,755 Holder for electric arc lamps; Joseph Pawlowski, Cincinnati, Ohio, assignor of one-half to Andrew Winter, West Covington, Ky.
395,761 Conduit for electric railways; Samuel Trott, Halifax, N. S., Canada.
395,769 Voltaic battery; Theophilus Cond, Forest Gate, County of Essex, England.
395,773 Cathode for an electric depositing apparatus; Elisha Emerson, Providence, R. I.
395,814 Support for aerial electric conductors; Henry H. Cutler, Newton, Mass.
395,836 Apparatus for charging and discharging secondary batteries; William P. Kookogey, Brooklyn, N. Y., assignor to the Kookogey Electric Co.
395,835 395,837 Method of preparing solution compounds for galvanic batteries; William P. Kookogey, Brooklyn, N. Y., assignor to the Kookogey Electric Co.
395,878 Process of electric welding; Charles L. Coffin, Detroit, Mich.
395,932 Medical battery; Henry E. Waite, New York, N. Y.
395,936 Regulator for incandescent electric lighting systems; Merle J. Wightman, Hartford, Conn.
395,950 Electric heating; John V. Capek, Brooklyn, assignor to himself and Edward H. Johnson, New York, N. Y.
395,958 395,959 Electric signaling apparatus; Mark W. Dewey, Syracuse, N. Y., assignor of two-thirds to Emil Laass and Charles H. Duell, same place.
395,961 Electric store service apparatus; Richard N. Dyer, East Orange, N. J.
395,962 Method of manufacturing electric lamps; Thomas A. Edison, Menlo Park, N. J., assignor to the Edison Electric Light Co., New York.

THE
PARKER-RUSSELL
MINING & MFG. CO.

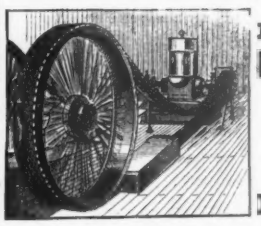
711 PINE STREET,
ST. LOUIS. MO.

GIVES MORE POWER USING LESS WATER THAN ANY OTHER WHEEL.

THE OLD RELIABLE
—LEFFEL—
WATER WHEEL
SEND FOR CATALOGUE.

JAMES LEFFEL & CO.
SPRINGFIELD, O., OR 110 LIBERTY ST., N.Y.

AMERICAN
Leather Link Belt Co.



"American Patent Joint"
LEATHER LINK BELTING
Specially adapted to
DYNAMOS.

FACTORY, 46 & 48 FERRY ST.,
OFFICE, 72 CLIFF STREET,
NEW YORK.
NEW YORK, CHICAGO, BOSTON PHILA.

WANTED.

YOUR NAME, BUSINESS AND ADDRESS. Send at once to me and be correctly reported in Whipple's

National Electrical Directory,

A postal card will do.
FRED H. WHIPPLE,
DETROIT, MICH.

NOTICE.

The demands of this wonderful Electric Age have been met by the Waltham Watch Co.'s Non-Magnetic Watches, and in accomplishing this the Watch has been brought to a state of perfection but a few years ago deemed impossible.

FOR SALE BY ALL LEADING JEWELERS.

American Waltham Watch Co.

O. K.

O. K.

Full Size!!!
NO ONE
Denies this to be the only safe automatic in the
LAND
Perfected
Improvements
Commend it to the Trade.
$6.00 EACH.
Discount (—).
A. L. BOGART,
22 Union Sq., N. Y.

CONDENSERS WM. MARSHALL, MANUFACTURER.
Standards a Specialty
Rooms 2 and 4, University Building, New York.

Detroit Electrical Works

MANUFACTURERS OF
ELECTRIC SUPPLIES,
INCLUDING
Medical Batteries, Skeleton and Box Bells, Burglar Alarms, House Annunciators, Fire Alarm Boxes, Pins and Brackets.

Insulated Magnet, Telephone and Electric Light Wire.

GENERAL OFFICES and FACTORY:
DETROIT, MICH.

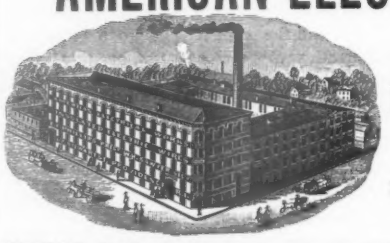
Warerooms, 224-232 Canal St., 118-126 Walker St.,
NEW YORK.
Manufactory, Flushing & Carlton Avenues, Brooklyn.

OXLEY, GIDDINGS & ENOS,
DESIGNERS AND MAKERS OF
Electroliers and Combination Fixtures

UNSURPASSED FACILITIES
For producing fixtures of the most approved designs for any system of
INCANDESCENT LIGHTING.
Special designs furnished upon application. Suggestions from architects and decorators faithfully executed.

EUGENE F. PHILLIPS, President. W. H. SAWYER, Secretary and Electrician.

AMERICAN ELECTRICAL WORKS

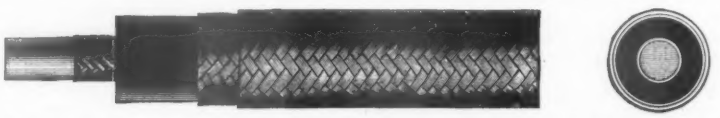


MANUFACTURERS OF
Patent Finished Insulated
ELECTRIC WIRES,
TELEPHONE AND ELECTRIC CORDAGE,
Electric Light Wire, Magnet Wire,
PATENT RUBBER COVERED WIRE, OFFICE AND ANNUNCIATOR WIRE, LEAD-ENCASED WIRE, ANTI-INDUCTION AERIAL AND UNDERGROUND CABLES, ETC., ETC.

OFFICE AND FACTORY, No. 67 STEWART ST., PROVIDENCE. R. I.
New York Office: 18 Cortlandt St., P. C. Ackerman, Agent.

THE "CLARK" WIRE

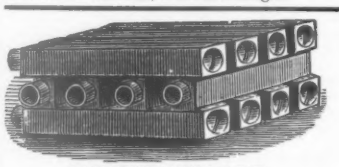
Insulation Guaranteed Wherever Used, Aerial, Underground or Submarine.



In a letter from the INSPECTOR of the **Boston Fire Underwriters' Union**, under date of March 29, 1886, he says: **"A Thoroughly Reliable and Desirable Wire in Every Respect."**

The rubber used in insulating our wires and cables is specially chemically prepared, and *is guaranteed to be waterproof*, and *will not deterioriate, oxidize* or *crack*, and will remain flexible in extreme cold weather, and not affected by heat. The insulation is protected from mechanical injury by one or more braids and the whole slicked with Clark's Patent Compound, which is water, oil, acid and, to a very great extent, fire proof. *Our insulation will prove durable when all others fail.* We are prepared to furnish Single Wires of all gauges and diameter of insulation for Telegraph, Telephone and Electric Lights from stock. Cables made to order.

EASTERN ELECTRIC CABLE COMPANY,
61 & 63 HAMPSHIRE STREET, BOSTON, MASS.
HENRY A. CLARK, General Manager. HERBERT H. EUSTIS, Electrician



SEND FOR CATALOGUE.

THE WYCKOFF PIPE CO.,

MANUFACTURERS OF
WOODEN PIPES FOR
UNDERGROUND ELECTRICAL WIRES.
We have large works for creosoting Lumber, R. R. Ties, Telegraph Poles, &c., &c.
WILLIAMSPORT, PENN.

GONDA BATTERY.

TRADE
GONDA
MARK.
THE STANDARD
Open Circuit Batteries
OF THE WORLD.

GONDA POROUS CUP BATTERY.

These Batteries, for Telephones, Call Bells, Gas Lighting, Burglar Alarms, House and Hotel Annunciators, Medical use, and all purposes for which open circuit batteries are required, stand unequalled and unapproachable.

DO NOT BE IMPOSED UPON BY IMITATIONS. Insist upon having the genuine "Gonda" batteries. Our trade mark is on every article used in them. See that every porous cell bears both label and trade mark.

THE LECLANCHÉ BATTERY CO.,
149 WEST 18th STREET, NEW YORK.

PENNSYLVANIA RAILROAD.

THE GREAT TRUNK LINE OF THE UNITED STATES.
The Most Direct Route to the West, Northwest, South and Southwest.
Four Fast Trains Daily Between NEW YORK AND WESTERN POINTS.
FINEST EQUIPMENT, UNEQUALED SPEED, AND GREATEST COMFORT.
Through Parlor, Sleeping and Hotel Cars on all Express Trains.
THE FAMOUS NEW YORK AND CHICAGO LIMITED EXPRESS
LEAVES NEW YORK DAILY AT 9:00 A. M.

This train is composed of the NEW and MAGNIFICENT PULLMAN VESTIBULED CARS, making the Safest, Easiest, and Most Luxurious Train in the World.
IN DAILY SERVICE BETWEEN NEW YORK, CHICAGO AND CINCINNATI.
Negotiations are pending relating to special transportation to the National Electric Light Convention, in Chicago
Tickets over the Pennsylvania Railroad and connecting lines can be obtained at the following offices;

849 Broadway, New York. 1 Astor House, New York. Foot of Cortlandt St., New York.
944 Broadway, " 4 Court Street, Brooklyn, N.Y. Foot of Desbrosses St., "
435 Broadway, " 1 Broadway, New York. Annex Office, Brooklyn, N. Y.
Pennsylvania R. R. Station, Jersey City.

CHARLES E. PUGH, General Manager, J. R. WOOD, Gen. Pass. Agent.
SAMUEL CARPENTER, Eastern Passenger Agent, 849 BROADWAY, N. Y.